SYLLABUS

2016-17

Aided By Govt. of Karnataka

Department of
Mechanical Engineering
3rd and 4th Semester

Dr. AMBEDKAR INSTITUTE OF TECHNOLOGY
(An Autonomous Institution, Affiliated to VTU, Belagavi)
Near JnanaBharathi Campus, BDA Outer Ring Road,
Mallathahalli, Bengaluru – 560056

Dr. AMBEDKAR INSTITUTE OF TECHNOLOGY
BANGALORE - 56
AIDED BY GOVERNMENT OF KARNATAKA
&
AN AUTONOMUS INSTITUTION AFFILIATED TO VTU, BELGAVI

Vision

- To create Dynamic, Resourceful, Adept and Innovative Technical professionals to meet global challenges.

Mission

- To offer state-of-the-art undergraduate, postgraduate and doctoral programs in the fields of Engineering, Technology And Management
- To generate new knowledge by engaging faculty and students in research, development and innovation.
- To provide strong theoretical foundation to the students, supported by extensive practical training to meet the industry requirements.
- To instill moral and ethical values with social and professional commitment.

SCHEME AND SYLLABUS FOR ADMISSION BATCH 2015-16

FOR 2015 BATCH - 3rd SEMESTER			L	T	P	C
1	MA31*	ENGINEERING MATHEMATICS – III *	4	0	0	4.0
2	ME31	FLUID MECHANICS	4	0	0	4.0
3	ME32	BASIC THERMODYNAMICS	4	0	0	4.0
4	ME33	MECHANICS OF MATERIALS	4	0	0	4.0
5	ME34	MANUFACTURING PROCESS – I	4	0	0	4.0
6	ME35	METROLOGY & MEASUREMENTS	3	0	0	3.0
7	MEL36	COMPUTER AIDED MACHINE DRAWING	2	0	4	4.0
8	MEL37	MANUFACTURING PROCESS LABORATORY – I	0	0	2	1.0
9	MEL38	METROLOGY & MEASUREMENTS LABORATORY	0	0	2	1.0
		THIRD SEMESTER TOTAL CREDITS				29.06
FOR 2016 BATCH - 3rd SEMESTER (lateral entry)						
1	MADIP31*	ADVANCED MATHEMATICS – I	4	0	0	4.0

FOR 2015 BATCH - 4rd SEMESTER			L	T	P	C
1	MA41*	ENGINEERING MATHEMATICS – IV	4	0	0	4.0
2	ME41	TURBO MACHINES	4	0	0	4.0
3	ME42	APPLIED THERMODYNAMICS	4	0	0	4.0
4	ME43	KINEMATICS OF MACHINES	4	0	0	4.0
5	ME44	MANUFACTURING PROCESS - II	4	0	0	4.0
6	ME45	MATERIAL SCIENCE & METALLURGY	3	0	0	3.0
7	MEL46	MATERIAL TESTING LABORATORY	0	0	2	1.0
8	MEL47	MANUFACTURING PROCESS LABORATORY -II	0	0	2	1.0
9	MEL48	FLUID MECHANICS & MACHINERY LABORATORY	0	0	2	1.0
		FOURTH SEMESTER TOTAL CREDITS				26.0
		SECOND YEAR TOTAL CREDITS				55.0
		CUMULATIVE CREDITS				105.0
FOR 2016 BATCH – 4th SEMESTER (lateral entry)						
1	MADIP41*	ADVANCED MATHEMATICS – II	4	0	0	4.0

III SEMESTER

Sub Title : ENGINEERING MATHEMATICS – III		
Sub Code: MA31	No of Credits : 4=3:1:0(L-T-P)	No of lecture hours/week :3+2=5
Exam Duration:3hours	CIEAssignment+SEE=45+5+50=100	Total no of contact hours:65

COURSE OBJECTIVES:

1. To understand Mathematical tools available to solve advanced engineering problems.

Unit No	Syllabus contents	Theory	Tutorial
1	**Fourier Series** : Definition and Euler formulae (without proof), statement of sufficient condition for convergence of the series. Fourier series of functions of period 2π, functions having arbitrary period, even and odd functions. Half-Range Expansions. Applications to forced oscillations and practical harmonic analysis.	08	05
2	**Fourier transforms:** Fourier complex integrals, Fourier sine and cosine integrals, Complex Fourier transforms, Fourier sine and cosine Transforms, Properties of Fourier transforms: Linearity, Change of scale, Shifting, Modulation, Fourier transform of derivatives, Relationship between Fourier and Laplace transform, Convolution theorem (without proof), Parseval's identity (no proof).	08	05
3	**Z-Transformations:**Definition, damping rule, shifting rule, initial value and final value theorems. Inverse Z-transform. Difference equations, applications of Z-transforms to solve difference equations.	08	05
4	**Numerical Methods-I:** Finite differences, Forward and backward differences, Newton's forward and backward interpolation formulae, Numerical differentiation. Divided differences - Newton's divided difference formula, Lagrange's interpolation formula and inverse interpolation formula. Numerical Solution of algebraic and transcendental equations: Secant method, Regulafalsi method, Newton - Raphson method.	08	05
5	**Numerical Methods-II:** Numerical solution of ordinary differential equations of first and second order; Euler's and Modified Euler's method, Runge-Kutta method of fourth-order. Milne's and Adams - Bashforth predictor and corrector methods (No derivations). **4**	08	05

Note 1: Units 1, 4 and 5 are compulsory, and Units 2 and 3 will have internal choices.

Note 2: Two Assignments are evaluated for 5 marks: Assignment - I from Units 1 and 2. Assignment - II from Units 3, 4 and 5.

Course Outcomes:

After the successful completion of the course the students are able to:

CO1: Understand the basic concepts of Integral Transforms and Numerical Methods.

CO2: Use Fourier and Z-transformations tools to solve problems related to Engineering field.

CO3: Understand the difference between Analytical and numerical methods.

CO4: Compare the viability of different approaches to the numerical solution of problems arising in finding roots of equations, interpolation and approximation, numerical differentiation and integration, and solution of ODE's.

CO5: Develop a variety of numerical algorithms using appropriate technology/ programming languages.

Cos	Mapping with POs
CO1:	PO1, PO2
CO2:	PO1, PO2
CO3:	PO1, PO2
CO4:	PO1, PO4
CO5:	PO1, PO2

TEXT BOOKS

1. B.S. Grewal, Higher Engineering Mathematics (Latest Edition, 2016), Khanna Publishers, New Delhi.
2. Erwin Kreyszig, Advanced Engineering Mathematics (10th Edition, 2016), Wiley Publishers, New Delhi.
3. Glyn James, Advanced Modern Engineering Mathematics (fourth edition, 2011), Pearson's Publisher.

REFERENCE BOOKS / Web links:

1. Peter V. O'Neil, Advanced Engineering Mathematics (7th Edition), Cengage Learning, Publishers U.S.A.
2. K.A.Stroud, Engineering Mathematics (Latest Edition), MACMILLAN (London)
3. John Bird, Engineering Mathematics (5th Edition, 2007), Elsevier.
4. H.K.Dass and Er. RajnishVerma, Advanced Engineering Mathematics (Latest Edn, 2015), S.Chand Publisher, New Delhi.
5. Dennis G Zill, MihaelGulle, Advanced Engineering Mathematics (2ndEdn), CBS publishers.
6. P.P.Gupta, Integral Transforms (4thEdn), KedarNath Ram Nath publishers.

CHAIRMAN/BOS   DEAN (ACADEMIC)   CHAIRMAN/ACADEMIC COUNCIL

III Semester (2015-16)

COURSE TITLE : FLUID MECHANICS		
Sub Code: ME31	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/week : 04
Exam Duration:3hours		Exam Marks : 100
Pre-requisites	Engineering Physics, Engineering Mathematics	

COURSE OBJECTIVES:

1. To explain various properties of fluids related to fluid mechanics.
2. To determine hydrostatic force and centre of pressure on plane and curved surfaces, locate metacentre and meta centric height of floating bodies.
3. To understand different types of pressure measurement devices.
4. To apply laws of conservation of momentum, mass and energy to fluid flow systems and explain the measurement of fluid flow parameters.
5. To interpret compressibility of gases in terms of Mach number.
6. To apply dimensional analysis and similarity laws for conducting model tests.

#	Contents	h
UNIT-1	**PROPERTIES OF FLUID**	**10**
	Introduction, classification of fluids, properties of fluids, viscosity, thermodynamic properties, surface tension, capillarity, vapour pressure, cavitation phenomenon.Numerical problems. FLUID STATICS**:** Fluid pressure at a point, Pascal's law, pressure variation in a static fluid, absolute, gauge, atmospheric and vacuum pressures, simple manometers and differential manometers. Total pressure and center of pressure on submerged plane surfaces; horizontal, vertical and inclined plane surfaces, curved surface submerged in liquid. Numericals	
UNIT-2	**BUOYANCY**	**12**
	Buoyancy, center of buoyancy, metacentre and metacentric height, conditions of equilibrium of floating and submerged bodies, determination of Metacentric height experimentally and theoretically. Numerical problems. KINEMATICS: Types of fluid flow, continuity equation in 2D and 3D (Cartesian Co-ordinates only), velocity and acceleration, Numerical problems. FLUID DYNAMICS**:** Introduction, Equation of motion, Euler's equation of motion, Bernoulli's equation from first principles and also from Euler's equation, limitations of Bernoulli's equation. Numericals	
UNIT-3	**FLUID FLOW MEASUREMENTS**	**10**
	Applications of Bernoulli's equation, Venturimeter, orificemeter, pitot-tube, vertical orifice, V-Notch and rectangular notches, Numerical problems.Navier-stoke's Equation. DIMENSIONAL ANALYSIS: Introduction, derived quantities, dimensions of physical quantities, dimensional homogeneity, Rayleigh's method, Buckingham p theorem, dimensionless numbers, similitude, types of similitude, dimensional analysis and similarity studies. Numericals	

UNIT-4	**FLOW THROUGH PIPES** Introduction, major and minor losses through pipes.Darcy's and Chezy's equation for loss of head due to friction in pipes.HGL and TEL. Numerical problems. LAMINAR FLOW AND VISCOUS EFFECTS: Reynold's number, critical Reynold's number, laminar flow through circular pipe-Hagen Poiseille's equation, laminar flow between parallel and stationary plates. Numericals.	**10**
UNIT-5	**FLOW PAST IMMERSED BODIES AND COMPRESSIBLE FLOW** Introduction, Drag, Lift, expression for lift and drag, boundary layer concept, displacement, momentum and energy thickness.Numerical problems. INTRODUCTION TO COMPRESS-IBLE FLOW: introduction – stagnation properties relationship, Velocity of sound in a fluid, Mach number, Mach cone, propagation of pressure waves in a compressible fluid. Numerical.	**10**

TEXT BOOKS

1. **A Textbook of Fluid Mechanics and Hydraulic Machines (SI Units)**, Dr. R.K. Bansal, Laxmi Publications (P) Limited, Revised 9th Edition,, 2010.
2. **Hydraulics and Fluid Mechanics including Hydraulic Machines**, Dr. P.N. Modi and S.M. Seth, Rajsons Publications Private Limited, Standard Book House, 2009.

REFERENCE BOOKS

1. **Fluid Mechanics: Fundamentals and Applications (SI Units),**Yunus A. Cengel, JohnM.Cimbala. McGraw-Hill Publications (SIE), 3rd Edition, 2014.
2. **Fluid Mechanics**, Frank M. White, McGraw-Hill Publications (SIE), 7th Edition, 2011.

e-LEARNING RESOURCES

1. **Fluid Mechanics: Mechanical Engineering Handbook,** Kreith,F, Berger, S.A, et. al., Ed. Frank Kreith, Boca Raton: CRC Press LLC, 1999.
2. **Videos and Lecture Notes:** http://www.nptel.ac.in

SYLLABUS COVERAGE FOR CIE

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)
CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4	5		

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q6 and Q7 from Unit1, Unit4 and Unit 5 respectively without choice.
2. Students shall answer Q2 or Q3 from Unit 2 and Q4 or Q5 from Unit3.
3. Each question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES: On completion of the course, student should be able to;
After completion of the course, students will be able to:

1. Define and describe fluid properties, define buoyancy and related laws, list the types of fluid flow and flow measuring devices, define non dimensional numbers, and describe concept of boundary layer.
2. Illustrate the laws of fluid mechanics with suitable examples; explain the different types of manometers and distinguish various equations of motion.
3. Apply the various equations and solve numerical problems related to fluid statics, kinematics and dynamics, laminar and viscous effects and compressible flow.
4. Compare the different types of flow measuring devices, analyze dimensions of physical quantities, classify flow types and evaluate non dimensional numbers.
5. Derive the equations of motion and other flow related equations, and develop various mathematical relations relevant to various flow regimes.
6. Calculate the various parameters for the given numerical problems.

MAPPING OF COs WITH POs

COs/POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : BASIC THERMODYNAMICS		
Sub Code: ME32	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/week : 04
Exam Duration:3hours		Exam Marks : 100
Pre-requisites	Engineering Physics, Engineering Mathematics	

COURSE OBJECTIVES:

1. To understand the fundamental concepts of thermodynamic system, process and cycle.
2. To explain work and heat transfer with illustrations and examples.
3. To interpret First and Second law of thermodynamics in the context of closed and opne system.
4. To understand the concept of entropy and the principle of increase of entropy.
5. To solve problems related to thermodynamic system applying the various thermodynamic relations to pure substances and gases.

#	Contents	h
UNIT-1	**FUNDAMENTAL CONCEPTS**	**08**
	Macroscopic and microscopic viewpoint, Thermodynamic system and control volume, Thermodynamic property, process and cycle, Homogeneous and heterogeneous system, Thermodynamic equilibrium, Quasi-static process, Pure substance, Concept of continuum, Thermostatics, Units and dimensions; Zeroth law of thermodynamics, Measurement of temperature, Comparison of thermometers, Ideal gas, Gas thermometers, Ideal gas temperature, Celsius temperature scale, electrical resistance thermometer, Thermocouple, International Practical Temperature Scale; Work transfer, pdV work – Path function and point function, pdV work in various quasi-static processes, Indicator diagram, Other types of work transfer, Free expansion with zero work transfer, Net work done by a system, Heat transfer, Heat transfer as a path function, Specific heat and latent heat, Comparison of heat and work transfer, Numericals	
UNIT-2	**FIRST LAW OF THERMODYNAMICS**	**10**
	First law of a closed system undergoing a cycle (Joule's experiment) and undergoing a change of state, Energy as a property of a system, Forms of stored energy, Specific heat at constatn volume and constant pressure, Enthalpy, Energy of an isolated system, PMM 1, Limitations of the First law; Application of First law to flow processes – Control volume, Steady flow process, Mass and energy balance in a simple steady flow process, Examples of steady flow processes, Comparison of SFEE with Euler and Bernoulli equations, Variable flow processes with examples, Discharging and charging a tank, Numericals.	
UNIT-3	**SECOND LAW OF THERMODYNAMICS**	**10**
	Qualitative difference between heat and work, Cyclic heat engine, Energy reservoirs, Kelvin-Planck and Clausius statement of Second law of thermodynamics, PMM 2, Refrigerator and heat pump, Equivalence of Kelvin-Planck and Clausius statements, Reversibility and irreversibility, Causes and conditions of irreversibility, Carnot cycle, Reversed heat engine, Carnot's theorem and its Corollary, Absolute thermodynamic temperature scale, Efficiency of the reversible heat engine, Equality of ideal gas and Kelvin temperatures, Types of irreversibility, Numericals.	

UNIT-4	**ENTROPY AND THERMODYNAMIC RELATIONS**	**12**
	Introduction, Clausius theorem, The property of entropy, T-s plot, Clausius inequality, Entropy change in an irreversible process, Entropy principle and its applications, Entropy transfer mechanisms, Entropy generation in a closed and open system, T-ds relations, Reversible adiabatic work in a steady flow system, Entropy and direction, Entropy and disorder; Thermodynamic relations – Maxwell equation, Tds equations, Difference in heat capacities, Ratio of heat capacities, Energy equation, Joule-Kelvin effect, Clausius-Clapeyron equation, Numericals.	
UNIT-5	**PROPERTIES OF PURE SUBSTANCES AND GASES**	**12**
	p-v diagram and p-T diagram for a pure substance, p-v-T surface, T-s and h-s diagram for a pure substance, Quality of pure substance, Steam tables – Saturation state, liquid-vapour mixture, compressed liquid, Charts of thermodynamic properties, Measurement of steam quality – Throttling calorimeter, Separating and throttling carlorimeter; Avogadro's law, Equation of state of gas, Ideal gas - Specific heat, internal energy and enthalpy, Entropy change, Thermodynamic property relations, work and heat transfer in reversible adiabatic, isothermal and poltropic processes of an ideal gas, Integral property relations, Viral expansions, Law of corresponding states, Generalised compressibility chart, Other equations of state, Numericals	

TEXT BOOKS

1. **Engineering Thermodynamics**, P.K. Nag, Tata McGraw Hill Education (India) Publications, 5th Edition, 2013.
2. **A Text Book of Engineering Thermodynamics**, R.K. Rajput, Laxmi Publishers, 3rd Edition, 2010.

REFERENCE BOOKS

1. **Thermodynamics:An Engineering Approach**, Yunus A. Cenegal and Michael A. Boles, McGraw-Hill Publications (SIE), 8th Edition, 2015.
2. **Fundamentals of Thermodynamics**, Claus Borgnakke and Richard E. Sonntag, Wiley Student Edition, 7th Edition, 2009.
3. **Principles of Engineering Thermodynamics**: **S.I. Version**, Moran and Shapiro, Wiley Student Edition, 2013.

e-LEARNING RESOURCES

1. **Videos and Lecture Notes:** http:// www.nptel.ac.in

DATA HAND BOOK

1. **Thermodynamics Data Book**, Richard E. Sonntag and Claus Borgnakke, Wiley Student Edition, 2nd Edition.

SYLLABUS COVERAGE FOR CIE

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)
CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit5.
3. Each question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Define and describe the thermodynamic system and its properties.
2. Interpret the laws of thermodynamics with examples and illustrations.
3. Sketch and draw the property variables on various thermodynamic planes.
4. Analyze the relations governing thermodynamic properties and their applications.
5. Apply knowledge of entropy and thermodynamic relations in various thermodynamic systems.
6. Evaluate the performance of engineering systems and processes based on laws of thermodynamics.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	1	1	1
6	3	3	2	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : MECHANICS OF MATERIALS		
Sub Code: ME33	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/week : 04
Exam Duration:3hours		Exam Marks : 100
Pre-requisites	Engineering Physics, Engineering Mathematics	

COURSE OBJECTIVES:

1. Understand mechanics of deformable bodies and apply them in analysis and design problems.
2. Analyze a body subjected to two dimensional and three dimensional stress systems.
3. Examine the behavior of a structural member in flexure.
4. Evaluate the slope and deflection in beams subjected to loading.
5. Assess the stability of columns and struts.
6. Interpret the torsional behavior of structural members.

#	Contents	h
UNIT-1	**SIMPLE STRESS AND STRAIN**	**12**
	Introduction, Stress, strain, mechanical properties of materials, Linear elasticity, Hooke's Law and Poisson's ratio, Stress-Strain relation – Ductile & Brittle, materials. Extension / Shortening of a bar, bars with cross sections varying in steps, bars with continuously varying cross sections (circular and rectangular), Elongation due to self-weight, Principle of super position. Stress in Composite Section**:** Volumetric strain, expression for volumetric strain, elastic constants, simple shear stress, shear strain, temperature stresses (including compound bars). Compound Stresses**:** Introduction, Plane stress, stresses on inclined sections, principal stresses and maximum shear stresses, Mohr's circle for plane stress.	
UNIT-2	**BENDING MOMENT AND SHEAR FORCE IN BEAMS**	**12**
	Introduction, Types of beams, loads and reactions, shear forces and bending moments, rate of loading, sign conventions, relationship between shear force and bending moments. Shear force and bending moment diagrams for different beams subjected to concentrated loads, uniformly distributed load, (UDL) uniformly varying load (UVL) and couple for different types of beams. Bending and Shear Stresses in Beams: Introduction, Theory of simple bending, assumptions in simple bending. Bending stress equation, relationship between bending stress, radius of curvature, relationship between bending moment and radius of curvature.Moment carrying capacity of standard sections. Shearing stresses in beams, shear stress across rectangular, circular, symmetrical I and T sections. (composite / notchedbeams not included).	
UNIT-3	**ENERGY METHODS**	**10**
	Work, strain energy, Strain energy in bar/beams, Castiglinios theorem, Energy methods	
UNIT-4	**DEFLECTION OF BEAMS**	**08**
	Introduction, Differential equation for deflection.Equations for deflection, slope and bending moment.Double integration method for cantilever and simply supported beams for point load, UDL, UVL and Couple. Macaulay's method	

UNIT-5	TORSION OF CIRCULAR SHAFTS AND ELASTIC STABILITY OF COLUMNS	10
	Introduction.Pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts. Power transmitted by solid and hollow circular shafts Columns**:** Euler's theory for axially loaded elastic long columns. Derivation of Euler's load for various end conditions, limitations, Rankine's formula	

COURSE OUTCOMES: On completion of the course, student should be able to;

1) Explain the concepts and principles applied to members under loadings, material properties.
2) Analyze structural members subjected to loads using the fundamental concepts of stress, strain and elastic behaviour of materials and thermal stresses.
3) Calculate the stresses on inclined plane by graphical method – Mohr's circle concept for different stress conditions
4) Develop BM & SF diagrams for cantilever & simply supported beams with different load conditions.
5) Relate bending stress, bending moment, radius of curvature, express shear stress in beams of different cross sections, and determine the deflection of beams subjected to different loads.
6) Analyze different machine elements such as shafts, pressure vessels for strength, rigidity and internal, external pressure respectively.

TEXT BOOKS:

1. **"Strength of Materials",** S.S. Rattan, Tata McGraw Hill, 2009
2. **"Strength of Materials", S. Ramamrutham**

REFERENCE BOOKS:

1. **"Mechanics of materials",** James. M. Gere, Thomson, Fifth edition 2004.
2. **"Mechanics of materials",** in S.I. Units, Ferdinand Beer & Russell Johnstan, Tata McGraw Hill- 2003.
3. **"Strength of Materials",**S.S.Bhavikatti, Vikas publications House -1 Pvt. Ltd., 2nd Ed., 2006.
4. **"Engineering Mechanics of Solids**", Egor.P. Popov, Pearson Edu. India, 2nd, Edison, 1998.

SCHEME OF EXAMINATION (SEE):

1. ONE FULL QUESTION from UNIT-3, UNIT-4 and UNIT-5 are COMPULSORY.
2. TWO FULL QUESTIONS each with CHOICE from UNIT-1 and UNIT-2 ONLY.
3. MAXIMUM of THREE SUB-DIVISIONS in EACH FULL QUESTION.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	1	1	1
6	3	3	2	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : MANUFACTURING PROCESS – I		
Sub Code: ME34	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/week : 04
Exam Duration:3hours		Exam Marks : 100

COURSE OBJECTIVES:

1. This course will introduce the student to the various manufacturing processes.
2. The course will begin by examining manufacturing processes including casting and welding processes.
3. For each manufacturing process, capabilities and limitations will be discussed.

#	Contents	h
UNIT-1	**INTRODUCTION**	**06**
	Concept of Manufacturing process, its importance. Classification of Manufacturing processes. Introduction to Casting process & steps involved. Components Varieties of produced by casting processes. Advantages & Limitations of casting process. **PATTERNS**: Definition, functions, Materials used for pattern, various pattern allowances and their importance. Classification of patterns, BIS color coding of Patterns. **BINDER**: Definition, Types of binder used in moulding sand. Additives: Need, Types of additives used and their properties.	
UNIT-2	**MOULDING PROCESSES**	**14**
	SAND MOULDING: Types of base sand, requirement of base sand. Moulding sand mixture ingredients for different sand mixtures. Method used for sand moulding, such as Green sand, dry sand and skin dried moulds. Cores: Definition, Need, Types. Method of making cores, Binders used, core sand moulding. Concept of Gating &Risers.Principle and types, Basic design of Gating and Riser with numericals. Basic steps, MouldingMachines : Jolt type, Squeeze type, Jolt & Squeeze type and Sand slinger. **SPECIAL MOULDING PROCESS:** Study of important moulding processes, No bake moulds, Flasklessmoulds, Sweep mould, CO2 mould, Shell mould, Investment mould. Metal moulds:	
UNIT-3	**MELTING AND CASTING PROCESSES**	**12**
	MELTING FURNACES Classification of furnaces, Constructional features & working principle of coke fired, oil fired and Gas fired pit furnace, Resistance furnace, Coreless Induction furnace, Electric Arc Furnace, Cupola furnace and process parameters affecting the furnaces. **CASTING PROCESSES** Gravity die-casting, Pressure die casting, Centrifugal casting, Squeeze Casting, Slush casting, Thixo-casting and Continuous Casting Processes.Fettling and cleaning of castings	
UNIT-4	**WELDING PROCESSES**	**10**
	INTRODUCTION: Definition, Principles, Classification, Application, Advantages & limitations of welding. Arc Welding: Principle, Metal Arc welding (MAW), Flux Shielded Metal Arc Welding (FSMAW), Inert Gas Welding (TIG & MIG)	

	RESISTANCE WELDING: Principles, Seam welding, Butt welding, Spot welding and projection welding. Friction welding, Explosive welding, Thermit welding, **RECENT WELDING PROCESSES:** Laser welding and Electron beam welding	
UNIT-5	**METALLURGICAL ASPECTS**	**10**
	DEFECTS IN CASTING AND WELDING Casting defects, Causes, features and remedies.Structure of welds, Formation of different zones during welding. Heat affected zone (HAZ). Parameters affecting HAZ.Effect of carbon content on structure and properties of steel. Welding defects – Detection causes & remedy. **INSPECTION METHODS** : Methods used for Inspection of casting and welding. Visual, Magnetic particle, Fluorescent particle, Ultrasonic, Radiography, Eddy current, Holography methods of Inspection	

COURSE OUTCOMES: On completion of the course, student should be able to;

1) Differentiate different manufacturing processes, select a particular casting process for a given application.
2) Compare capabilities and characteristics of different sand and special moulding processes.
3) Understand the working principle and capabilities of different melting furnaces followed by understanding the special features and capabilities of different casting processes.
4) Apply particular welding process to produce sound weld.
5) Analyze the causes, features and remedies of casting and welding defects

TEXT BOOKS:

1. **"Manufacturing Process-I & II",** Dr. K. Radhakrishna, Sapna Book House, 5th Revised Edition 2009.

2. **"Manufacturing & Technology**: Foundry Forming and Welding", P.N. Rao 2nd Ed., TMH, 2003.

3. **Manufacturing Science**, AmitabhaGhoshandMallik, affiliated East West Press, 2003.

4. **Metal Casting: Principles and Practice**, T.V. RamanaRao,Published by New Age International (P) Limited (2010)

5. Principles of Metal Casting, MahiSahoo , Sam Sahu **, McGraw Hill Education (India) Private Limited; Third edition (26 September 2014)**

REFERENCE BOOKS:

1. **"Manufacturing Technology**", SeropeKalpakjain, Steuen.R. Sechmid, Pearson Education Asia, 5th Ed. 2006.

2. **"Process and Materials of Manufacturing**", Roy A Lindberg, 4th Ed. Pearson Edu. 2006.

3. **Principles Of Metal Casting- Second Edition**, Heine, Richard W.; Carl R. Loper, Jr. & Philip C. Rosenthal, Published by McGraw-Hill, New York (1967)

4. **Mechanical Metallurgy Paperback ,** George E. Dieter**TMH**

SCHEME OF EXAMINATION (SEE):

1. ONE FULL QUESTION from UNIT-1, UNIT-4 and UNIT-5 are COMPULSORY.
2. TWO FULL QUESTIONS with CHOICE from UNIT-2 and UNIT-3 ONLY.
3. MAXIMUM of THREE SUB-DIVISIONS in EACH FULL QUESTION.

MAPPING OF COs WITH POs

COs/POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	1	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : METROLOGY AND MEASUREMENTS		
Sub Code: ME35	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/week : 03
Exam Duration:3hours		Exam Marks : 100

COURSE OBJECTIVES:

1. Explain the concepts of measurement and gauging instruments.
2. Appreciate the relevance with regards to practical applications.
3. Explain and apply the principles in manufacturing industries.

#	Contents	h
UNIT-1	**STANDARDS OF MEASUREMENT**	**08**
	Definition and Objectives of metrology, Standards of length-International prototype meter, Imperial standard yard, Wave length standard, subdivision of standards, line and end standard, calibration of end bars (Numerical), Slip gauges, Wringing phenomena, Indian Standards (M-81, M-12), Numerical problems on building of slip gauges. System of Limits, Fits, Tolerance and Gauging**:** Definition of tolerance, Specification in assembly, Principle of interchangeability and selective assembly limits of size, Indian standards, concept of limits of size and tolerances, compound tolerances, accumulation of tolerances, definition of fits, types of fits and their designation (IS919-1963), geometrical tolerance, positional-tolerances, hole basis system, shaft basis system.	
UNIT-2	**CLASSIFICATION OF GAUGES**	**10**
	Brief concept of design of gauges (Taylor's principles), Wear allowance on gauges, Types of gauges-plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials. Comparators and Angular measurement: Introduction to comparators, characteristics, classification of comparators, mechanical comparators-Johnson Mikrokator, sigma comparators, dial indicator, optical comparators-principles, Zeiss ultra optimeter, electric and electronic comparators-principles, LVDT, pneumatic comparators, back pressure gauges, solex comparators. Angular measurements, bevel protractor, sine principle and use of sine bars, sine centre, use of angle gauges (numericals on building of angles), clinometers. **MEASUREMENT OF SURFACE ROUGHNESS** Parameters of 2D and 3D surface parameters.Measurement of form-Straightness, flatness, perpendicularity, parallelism, roundness and cylindricals	
UNIT-3	**INTERFEROMETER, SCREW THREAD AND GEAR MEASUREMENT**	**10**
	Interferometer, interferometry, autocollimator. Optical flats. Terminology of screw threads, measurement of major& minor diameters, pitch, angle and effective diameter of screw threads by 2& 3-wire methods, best size wire.Tool maker's microscope, gear tooth, terminology, use of gear tooth vernier caliper and micrometer. Measurements and measurement systems**:** Definition, significance of measurement, generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hysterisis, repeatability, linearity, loading effect, system response-times delay. Errors in measurement, classification of errors.Transducers, transfer efficiency, primary and secondary transducers, electrical, mechanical, electronic transducers, advantages of each type of transducers.	

UNIT-4	INTERMEDIATE MODIFYING AND TERMINATING DEVICES	06
	Mechanical systems, electronic amplifiers and telemetry. Terminating devices, mechanical, cathode ray oscilloscope, oscillographs, X-Y plotters. **MEASUREMENT OF FORCE, TORQUE AND PRESSURE** Principle, dynamometer, proving ring.Torque measurement.	
UNIT-5	**PRESSURE MEASUREMENTS**	**05**
	Principle, use of elastic members, Bridgeman gauge, McLeod gauge, Pirani gauge. Temperature and strain measurement**:** Resistance thermometers, Thermocouple, Law of thermocouple, Materials used for construction, Pyrometer, Optical pyrometer. Strain measurements, preparation and mounting, gauge factor, methods of strain measurement, Co-ordinate Measuring Machine (CMM) - Principle of operation, working and applications.	

COURSE OUTCOMES: On completion of the course, student should be able to;

1) Describe different standards and the importance of standardization.
2) Recognize measurements necessity, various dimensional measurements.
3) Design measurement system for a given parameter
4) List the different kinds of sensors, transducers, and recorders.
5) Assess measurement system with its limitations.

TEXT BOOKS:

1. **Mechanical Measurements,** Beckwith Marangoni and Lienhard, Pearson Education, 6th Edition, 2006. (For Measurements Only)
2. **Engineering Metrology,** R.K. Jain, Khanna Publishers, 1994. (For Metrology Only)

REFERENCE BOOKS:

1. **Engineering Metrology,** I.C. Gupta, DhanpatRai Publications, Delhi.
2. **Mechanical Measurements,** R.K. Jain
3. **Industrial Instrumentation,** Alsutko, Jerry. D. Faulk, Thompson Asia Pvt. Ltd.2002.
4. **Measurement Systems Applications and Design,** Ernest O. Doblin, McGraw Hill

SCHEME OF EXAMINATION (SEE):

1. ONE FULL QUESTION from UNIT-1, UNIT-4 and UNIT-5 are COMPULSORY.
2. UNIT -2 and UNIT-3 WILL HAVE INTERNAL CHOICE ONLY.
3. MAXIMUM of THREE SUB-DIVISIONS in EACH FULL QUESTION

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	1	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : COMPUTER AIDED MACHINE DRAWING		
Sub Code: MEL36	No of Credits : L-T-P-SS 02:00:04:00 =04	No. of lecture hours/week : 06
Exam Duration:3hours		Exam Marks : 50

COURSE OBJECTIVES:

1. To understand the sectional views and thus developments of various solid shapes
2. Simple machine parts orthographic views with and without sections to be understood
3. Different types of thread forms to be studied
4. Permanent and temporary fasteners study
5. Assembly drawings in 2D of several joints and couplings

#	Contents	h
UNIT-1	**SECTIONS OF SOLIDS**	**16**
	Prisms, pyramids, cones, cylinders cut by a single section plane perpendicular to Vertical Plane and inclined to Horizontal Plane **ORTHOGRAPHIC PROJECTIONS** Orthographic views of simple machine parts with and without sections	
UNIT-2	**RIVETED JOINT**	**16**
	Single riveted lap joints, double riveted lap joints, with chain and zig-zag type, Single riveted butt joints with single and double cover plates, Double riveted butt joints with single and double cover plates with chain and zig-zag riveting **2D ASSEMBLY DRAWINGS - COUPLINGS** Split muff, protected type flange, Oldham's coupling	
UNIT-3	**ASSEMBLY**	**46**
	Screw jack (Bottle type), Plummer block (Pedestal Bearing) and Machine vice	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Viewing a section with a specific orientation to understand interior details.
2. Identifying several thread forms and pinpointing their usage
3. Realise Fasteners and their importance with specific decision to select the right type of fastener for the right job
4. Make Assembly of various parts of joints and couplings

TEXT BOOKS:

1. **'Computer Aided Machine Drawing-2007'**, Published by VTU, Belgaum.

REFERENCE BOOKS:

1. **'Machine Drawing'**, K.R. Gopala Krishna, Subhash Publication.
2. **'Machine Drawing'**, N. D. Bhat& V. M. Panchal
3. **Computer Aided Machine Drawing'**, S. Trymbaka Murthy, CBS Publishers, New Delhi, 2007.

CONTINUOUS INTERNAL EVALUATION (CIE)

1. CIE has a maximum of 50 marks.
2. All the sheets should be drawn in the class using Solid edge software. Sheet sizes should be A4. All sheets must be submitted at the end of the class by taking printouts.
3. CIE Marks is finalized by conducting a test at the end of 10^{th} week of the semester.
4. CIE Marks (50) = Evaluation of Record (Sketch-15 and Printout-15) + Test (20)

SCHEME OF EXAMINATION (SEE):

1. Total number of full questions to be set: 06.
2. Two question to be set from each unit compulsorily
3. Student has to answer one question from each unit

UNIT – 1	**=**	**10 Marks**
UNIT – 2	**=**	**10 Marks**
UNIT – 3	**=**	**30 Marks**
Total	**-**	**50 marks**

MAPPING OF COs WITH POs

COs/POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : MANUFACTURING PROCESS LABORATORY- I		
Sub Code: MEL37	No of Credits : L-T-P-SS 00:00:02:00 =01	No. of lecture hours/week : 02
Exam Duration:3hours		Exam Marks : 50

COURSE OBJECTIVES:

1. This course will give the student knowledge of testing sand used in foundries.
2. It also focuses on preparation of sand moulds, forging a component.

#	Contents	h
UNIT-1	**TESTING OF MOLDING SAND AND CORE SAND**	**08**
	Preparation of sand specimens and conduction of the following tests: 1 Compression, Shear and Tensile tests on Universal Sand Testing Machine. 2 Permeability test 3 Core hardness &Mould hardness tests. 4 Sieve Analysis to find Grain Fineness number of Base Sand 5 Clay content determination in Base Sand	
UNIT-2	**FOUNDRY PRACTICE**	**09**
	➢ Use of foundry tools and other equipments. ➢ Preparation of moulds using two moulding boxes using patterns or without patterns. (Split pattern, Match plate pattern and Core boxes). ➢ Preparation of one casting (Aluminum or cast iron-Demonstration only)	
	OR	
UNIT-3	**FORGING OPERATIONS**	**09**
	➢ Calculation of length of the raw material required to do the model. ➢ Preparing minimum three forged models involving upsetting, drawing and bending operations. Out of these three models, at least one model is to be prepared by using Power Hammer	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Test and analyze the properties of sand used in foundries as per international standards.
2. Develop a mould for simple applications.
3. Fabricate a simple forging components using different tools .

CONTINUOUS INTERNAL EVALUATION (CIE)

1. CIE has a maximum of 50 marks.
2. CIE Marks is finalized by conducting a test at the end of 10th week of the semester.
3. CIE Marks (50) = Evaluation of Record (30) + Test (20)

REFERENCE BOOKS:

1. **"Manufacturing & Technology**: Foundry Forming and Welding", P.N. Rao 2nd Ed., Tata McGraw Hill, 2003.

2. **Manufacturing Science**, AmitabhaGhosh and Mallik, affiliated East West Press, 2003.
3. **Metal Casting: Principles and Practice**, T.V. RamanaRao,Published by New Age International (P) Limited (2010)
4. **Principles of Metal Casting,** MahiSahoo **,** Sam Sahu **, McGraw Hill Education (India) Private Limited; Third edition (26 September 2014)**

SCHEME OF EXAMINATION (SEE):

1.	One Compulsory Model from UNIT -1	15 marks
2.	One optional Model from UNIT - 2	25 marks
	OR	
3.	One optional Model from UNIT - 3	25 marks
4.	Viva – Voce	10 marks
	TOTAL	50 marks

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : METROLOGY AND MEASUREMENTS LABORATORY		
Sub Code: MEL38	No of Credits : L-T-P-SS 00:00:02:00 =01	No. of lecture hours/week : 02
Exam Duration:3hours		Exam Marks : 50

COURSE OBJECTIVES:

1. Calibration of vital tools including micrometer in measurements laboratory
2. Calculate modulus of elasticity of a ductile specimen
3. Measurement of parameters like; Angle, Alignment, Cutting tool forces, Screw thread, Surface roughness and Gear tooth profile

#	Contents	h
UNIT-1	**MEASUREMENTS**	**12**
	1. Calibration of Pressure Gauge 2. Calibration of Thermocouple 3. Calibration of LVDT 4. Calibration of Load cell 5. Determination of modulus of elasticity of a ductile specimen using strain gauges	
UNIT-2	**METROLOGY**	**14**
	1. Measurements using Optical Projector / Toolmaker Microscope. 2. Measurement of angle using Sine Center / Sine bar / bevel protractor 3. Measurement of alignment using Autocollimator / Roller set 4. Measurement of cutting tool forces using-Lathe tool & Drill tool Dynamometer. 5. Measurement of Screw threads Parameters using Two wire or Three-wire method. 6. Measurements of Surface roughness, Using Tally Surf/Mechanical Comparator 7. Measurement of gear tooth profile using gear tooth vernier / Gear tooth micrometer 8. Calibration of Micrometer using slip gauges 9. Measurement using Optical Flats	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Vital tools calibration methods are understood in the metrology section
2. To the measurements section several important parameters are measured using several versatile equipments.

REFERENCE BOOKS:

1. **Mechanical Measurements,** Beckwith Marangoni and Lienhard, Pearson Education, 6th Edition, 2006. (For Measurements Part Only)
2. **Engineering Metrology,** R.K. Jain, Khanna Publishers, 1994
3. **'Mechanical Measurements and Metrology',** Dr. T. Chandrashekar, Subhash Stores, 3rd Edition, 2009.

CONTINUOUS INTERNAL EVALUATION (CIE)

1. CIE has a maximum of 50 marks.
2. CIE Marks is finalized by conducting a test at the end of 10^{th} week of the semester.
3. CIE Marks (50) = Evaluation of Record (30) + Test (20)

SCHEME OF EXAMINATION (SEE):

1.	ONE question from PART A	-	15 Marks
2.	ONE question from PART B	-	25 Marks
3.	Viva –Voce	-	10 Marks
	Total	**-**	**50 Marks**

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1

Strong-3, Medium-2, Weak-1

IV SEMESTER

Sub Title : ENGINEERING MATHEMATICS – IV		
Sub Code: MA41	No of Credits : 4=3:1:0(L-T-P)	No of lecture hours/week :3+2=5
Exam Duration:3hours	CIE + Assignment + SEE =45 + 5 + 50=100	Total no of contact hours:65

COURSE OBJECTIVES:

1. To introduce Mathematical methods to test and solve highly complex engineering problems

Unit No	Syllabus contents	No of Hours	
		Theory	Tutorial
1	**Functions of a complex variable:** Definitions of continuity, differentiability and analytic functions, Cauchy-Riemann equations in Cartesian and polar forms, properties of analytic functions: Harmonicity, orthogonality. Construction of analytic functions and its applications. Conformal Transformations, Bilinear Transformations, Discussion of transformations: $w = z^2$, $w=e^z$, $w=z+(a^2/z)$.	08	05
2	**Complex Integration:** Complex line integrals-Cauchy's theorem and Cauchy's integral formula. Taylor's and Laurent's series (no proof), Poles and Residues, Residue theorem(no proof), contour integration of Type-I and Type-II.	08	05
3	**Special functions:** Series solution of Bessel's differential equation leading to Bessel function of first kind, generating function. Recurrence relations of Bessel functions. Series solution of Legendre's differential equation leading to Legendre polynomials, Rodrigue's formula, generating function. Recurrence relations of Legendre functions.	08	05
4	**Curve fitting and Probability Distributions:** Method of least square, curve fitting- normal equations, Linear, exponential and quadratic forms. Recap of random variables. Probability distributions, Binomial and Poisson distributions with derivations of mean and standard deviations. Normal and Standard normal distribution (no derivations).	08	05
5	**Numerical Methods –III:** Evaluation of Integrals using Simpson's one-third, three-eighth and Weddle's rules (all rules without proof), Numerical solutions of PDE – finite difference approximation to derivatives, Numerical solution heat, wave and Laplace equations.	08	05

Note 1: Units 2, 4 and 5 are compulsory, and Units 1 and 3 will have internal choices.

Note 2: Two Assignments are evaluated for 5 marks: Assignment - I from Units 1 and 2. Assignment - II from Units 3, 4 and 5.

Course Outcomes:

After the successful completion of the course the students are able to:

CO1: Understand basic concepts of Complex functions, analyticity and Integrals of complex valued functions, and probability distributions.

CO2: Create complex functions like stream functions, potentials functions required in Engineering fields.

CO3: Create special functions of some typical ODE's.

CO4: Demonstrate understanding of how to translate: the functions of one complex plane to the other, real-word problems into probability models, and PDEs into grid regions.

CO5: Implement a variety of numerical algorithms to solve integrals and particular PDE's of engineering interest.

CO's	Mapping with PO's
CO1:	PO1, PO2
CO2:	PO1, PO2
CO3:	PO1, PO2
CO4:	PO1, PO2, PO4
CO5:	PO1, PO2

TEXTBOOKS:

1. B.S. Grewal, Higher Engineering Mathematics (Latest Edition, 2016), Khanna Publishers, New Delhi.
2. Erwin Kreyszig, Advanced Engineering Mathematics (10th Edition, 2016), Wiley Publishers, New Delhi.

REFERENCE BOOKS / Web links:

1. Peter V. O'Neil, Advanced Engineering Mathematics (7th Edition), Cengage Learning, Publishers U.S.A.
2. Glyn James, Advanced Modern Engineering Mathematics (fourth edition, 2011), Pearson's Publisher.
3. K.A.Stroud, Engineering Mathematics (Latest Edition), MACMILLAN (London)
4. John Bird, Engineering Mathematics (5th Edition, 2007), Elsevier.
4. H.K.Dass and Er. RajnishVerma, Advanced Engineering Mathematics (Latest Edn, 2015), S.Chand Publisher, New Delhi.
5. Dennis G Zill, MihaelGulle, Advanced Engineering Mathematics (2ndEdn), CBS publishers.
6. P.P.Gupta, Integral Transforms (4thEdn), KedarNath Ram Nath publishers.

CHAIRMAN/BOS DEAN (ACADEMIC) CHAIRMAN/ACADEMIC COUNCIL

IV Semester (2015-16)

COURSE TITLE : TURBO MACHINES		
Sub Code: ME41	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/week : 04
Exam Duration:3hours		Exam Marks : 100
Pre-requisites	Fluid Mechanics, Basic Thermodynamics	

COURSE OBJECTIVES:

1. To outline the working principle of turbo machines with examples. Classifies turbo machines and describes the energy transfer mechanism of turbo machines
2. To explain the functioning of radial flow and axial flow turbo machines such as centrifugal pumps, compressors, steam, gas and hydraulic turbines
3. To demonstrate the effect of important variables affecting the output of turbo machines.
4. To sketch the velocity diagrams for various types of turbo machines
5. To analyze a given problem and apply the fundamental knowledge to solve the problem
6. To estimate and evaluate unknown parameters and predict the performance of turbo machines

#	Contents	h
UNIT-1	**INTRODUCTION AND GENERAL ANALYSIS OF TURBO MACHINES**	**10**
	Definition of a turbo machine; parts of a turbo machine; comparison with positive displacement machine; classification; Energy transfer in a turbomachine - Euler turbine equation; alternate form of Euler turbine equation (components of energy transfer); degree of reaction, utilization factor and relationship between them; Maximum utilization factor; General analysis of radial flow turbomachines (turbines and pumps) - Effect of blade discharge angle on their performance; Theoretical head-capacity relationship; Related numericals.	
UNIT-2	**GENERAL ANALYSIS OF AXIAL FLOW TURBO MACHINES**	**08**
	General analysis of axial flow turbines – utilization factor, degree of reaction, relationship between utilization factor and blade speed ratio; Maximum utilization factor and optimum blade speed ratio for impulse and reaction axial flow turbines; General analysis of axial flow compressors and pumps – general expression for energy transfer and degree of reaction; Related numericals	
UNIT-3	**STEAM TURBINES**	**10**
	Introduction; Different efficiencies; Analysis of single stage impulse (De Laval) turbine; Impulse staging and need for compounding; Analysis of velocity compounded impulse (Curtis) turbine; Analysis of Impulse-reaction (Rateau) turbine; Reheat factor for multi stage turbine; Related numericals.	
UNIT-4	**HYDRAULIC TURBINES**	**12**
	Introduction; Classification; Different heads and efficiencies; Pelton turbine-velocity triangles; Francis turbine-velocity triangles, runner shapes for different blade speeds; function of a draft tube, types of draft tube; Kaplan and Propeller turbines – velocity triangles and analysis; Related numerical problems; Specific speed and its significance; Unit quantities and their uses; Characteristic curves of hydraulic turbines.	

UNIT-5	CENTRIFUGAL PUMPS AND COMPRESSORS	12
	Centrifugal pumps –Introduction, Main parts of a centrifugal pump; Work done; Definitions of heads and efficiencies; minimum speed for starting; Multistage centrifugal pump; Specific speed; Priming; Characteristic curves; Cavitation; Thoma's cavitation factor; Maximum suction lift; Net positive suction head; Related numerical problems: Centrifugal compressors-Introduction; Work done; Overall pressure ratio developed; Pressure ratio in terms of ϕ_s, ϕ_p, ϕ_w; Compressibility and pre-whirl; Diffuser design; Surging; Related numericals	

TEXT BOOKS

1. **Turbo Machines**, Dr. N. Krishnamurthy, Sunstar Publisher, 2nd Edition, 2015.
2. **Turbomachines**, B.U. Pai, Wiley Precise Textbook Series, 2014.
3. **A Textbook of Fluid Mechanics and Hydraulic Machines (SI Units)**, Dr. R.K. Bansal, Laxmi Publications (P) Limited, Revised 9th Edition, 2010.

REFERENCE BOOKS

1. **An introduction to energy conversion, Vol. III – Turbomachinery**, V. Kadambi and Manohar Prasad, 2nd Edition, New Age International Publishers (P) Limited, 2011.
2. **Principles of turbomachinery**, D. G. Shepherd, MacMillan Company, 1964.

SYLLABUS COVERAGE FOR CIE

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)
CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit5.
3. Each question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES: On completion of the course, student should be able to; After the completion of the course, students will be able to:

1. Describe the general working of turbo machines
2. Illustrate the functioning of radial flow and axial flow turbo machines with examples.
3. Sketch and draw the velocity diagrams for turbo machines.
4. Classify and analyze the various types of turbo machines.
5. Derive various equations related to the performance of turbo machines
6. Evaluate and compute the performance of various turbo machines.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	2	1	2	1	1	1	1	1	1	1
2	3	3	3	1	2	1	1	1	1	2	1	1
3	3	3	2	1	1	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	2	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	1	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : APPLIED THERMODYNAMICS		
Sub Code: ME42	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/week : 04
Exam Duration:3hours		Exam Marks : 100
Pre-requisites	Engineering Physics, Engineering Mathematics	

COURSE OBJECTIVES:

1. To relate the fundamentals of thermodynamics to the real time applications.
2. To describe the various thermodynamic power cycles which use air and vapour as the working fluid
3. To apply the fundamental concepts to derive various thermodynamic variables for solving numerical problems
4. To design and develop various thermodynamic systems and predict their performance

#	Contents	h
UNIT-1	**AIR STANDARD POWER CYCLES**	**08**
	Introduction; Air Standard cycles-Description of various processes, p-v and T-s diagrams, derivation of efficiency and mean effective pressure of Carnot, Otto, Diesel and Dual combustion cycles; Comparison of Otto, Diesel and Dual combustion cycles in terms of same compression ratio, same heat input and maximum cycle pressure; Related numericals	
UNIT-2	**RECIPROCATING COMPRESSORS**	**10**
	Introduction; Working principle, p-v diagram and derivation of work input of a single stage reciprocating compressor; Adiabatic, isothermal and mechanical efficiencies; Effect of clearance and derivation of volumetric efficiency; Multistage compressor; Saving in work, optimum intermediate pressure, inter-cooling, minimum work for compression; Related numericals	
UNIT-3	**VAPOUR POWER CYCLES**	**10**
	Introduction; Performance parameters; Carnot vapour power cycle; Rankine cycle; Influence of thermodynamic variables in Rankine cycle; Actual vapour power cycle; Comparison of Rankine and Carnot cycles; Mean temperature of heat addition; Reheat cycle; Ideal and practical regenerative cycle; Reheat-regenerative cycle; Feedwater heaters; Binary vapour power cycles; Numerical problems on Carnot cycle, Rankine cycle, Reheat cycle and Regenerative cycle.	
UNIT-4	**REFRIGERATION CYCLES**	**12**
	Introduction; Units of refrigeration; COP; Reversed heat engine cycle; Vapour compression refrigeration cycle; Performance and capacity of a vapour compression plant; Actual vapour compression cycle; Effect of change in operating conditions on the performance of vapour compression cycle; Components in a vapour compression plant; Multi-stage vapour compression systems; Multi-evaporator systems; Cascade systems; Refrigerants; Selection of a refrigerant; Absorption refrigeration system and theoretical COP; Electrolux refrigerator; Steam jet refrigeration system; Gas cycle refrigeration; Polytropic and multistage compression; Application to aircraft refrigeration; Bootstrap system; Numerical problems on reversed heat engine cycle, vapour compression cycle and aircraft refrigeration cycle.	

UNIT-5	GAS TURBINE PLANTS AND JET PROPULSION SYSTEM	12
	Introduction; Classification and comparison; Application of gas turbines; Advantages and disadvantages of gas turbine plants; Analysis of simple constant pressure gas turbine cycle (Brayton cycle); Methods to improve the performance of gas turbine plant – Regenerative and reheat gas turbine cycle; Gas turbine cycle with intercooling; Gas turbine cycle with reheat and regeneration; Gas turbine with reheat and intercooling; Gas turbine with regeneration, reheat and intercooling; Gas turbine irreversibilities and losses; Compressor and turbine efficiency; Gas turbine cycles for jet propulsion, Thrust, Propulsive power and propulsive efficiency; Classification of gas turbine engines, Comparison of various propulsion devices; Numericals	

TEXT BOOKS

1. **Basic and Applied Thermodynamics,** P.K. Nag, Tata McGraw-Hill Publications, 2nd Edition, 2010.
2. **Applied Thermodynamics,** Omkar Singh, New Age International (P) Limited, 2003.
3. **Gas Turbines and Jet Rocket Propulsion**, V.M. Domkundwar, DhanpatRai& Co. (P) Limited, 2nd Edition, 2013.

REFERENCE BOOKS

1. **A Course in Thermal Engineering,** A. Domkundwar, C.P. Kothandaraman, S. Domkundwar, DanpatRai and Co (P) Limited, 2013.

e-LEARNING RESOURCES

1. **Videos and Lecture notes:** http:// www.nptel.ac.in

DATA HAND BOOKS AND CHARTS

1. **Steam Tables with Mollier Diagram: SI Units**, Mahesh M. Rathore, DhanpatRai Publishing Company, 2014.
2. **Refrigeration Tables and Charts: SI Units,** C.P. Kothandaraman**,** 4th Edition, New Age International Publishers, 2015.

SYLLABUS COVERAGE FOR CIE

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)
CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit5.
3. Each question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES: On completion of the course, student should be able to;

After the completion of the course, students will be able to:

1. Identify and describe thermodynamic power cycles and refrigeration cycles.

2. Explain the various thermodynamic cycles giving examples and illustrations.

3. Sketch and draw thermodynamic cycles to solve for various parameters by applying the basic principles of thermodynamics.

4. Compare and analyse different types of thermodynamic cycles.

5. Derive various expressions to measure the performance of thermodynamic power cycles and refrigeration cycles.

6. Calculate and compute the performance of various thermal engineering systems.

MAPPING OF COs WITH POs

COs/POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	1	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	2	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : KINEMATICS OF MACHINES		
Sub Code: ME43	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/week : 04
Exam Duration:3hours		Exam Marks : 100
Pre-requisites	Engineering Physics, Engineering Mathematics	

COURSE OBJECTIVES:

1) Explain the types of relative motion.
2) Differentiate between Machine, Mechanism, and Structure.
3) Draw the velocity and acceleration diagram of various linkages.
4) Determine the gear parameters and check for interference.
5) Calculate the fixing torque in gear trains.
6) Design the Cam profile for the desired follower motion.

#	Contents	h
UNIT-1	**INTRODUCTION**	**10**
	Definitions Link or element, kinematic pairs, Degrees of freedom, Grubler's criterion (without derivation), Kinematic chain, Mechanism, Structure, Mobility of Mechanism, Inversion, Machine. **KINEMATIC CHAINS AND INVERSIONS** Inversions of Four bar chain; Single slider crank chain and Double slider crank chain. Practical applications. **MECHANISMS** Quick return motion mechanisms-Drag link mechanism, Whitworth mechanism and Crank and slotted lever Mechanism. Straight line motion mechanisms Peaucellier's mechanism and Robert's mechanism. Intermittent Motion mechanisms -Geneva wheel mechanism and Ratchet and Pawl mechanism. Toggle mechanism, Pantograph, Ackerman steering gear mechanism.All wheel drive mechanism.	
UNIT-2	**VELOCITY AND ACCELERATION ANALYSIS OF MECHANISMS (GRAPHICAL METHODS)**	**10**
	Velocity and acceleration analysis of Four Bar mechanism, Slider crank mechanism and Simple Mechanisms by vector polygons: Relative velocity and acceleration of particles .in a common link, relative velocity and accelerations of coincident Particles on separate links- Coriolis component of acceleration. Angular velocity and angular acceleration of links, velocity of rubbing.	
UNIT-3	**VELOCITY ANALYSIS BY INSTANTANEOUS CENTER METHOD**	**10**
	Definition, Kennedy's Theorem, Determination of linear and angular velocity using instantaneous center method **KLEIN'S CONSTRUCTION**: Analysis of velocity and acceleration of single slider crank mechanism	
UNIT-4	**GEARS**	**12**
	Spur gears and its terminology, law of gearing, Characteristics of involute action, Path of contact, Arc of contact, Contact ratio of spur, helical, bevel and worm gears, Interference in involute gears. Methods of avoiding interference, Backlash, Comparison of involute and cycloidal teeth.	

	GEAR TRAINS: Simple gear trains, Compound gear trains for large speed reduction, Epicyclic gear trains, Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains. Tooth load and torque calculations in epicyclic gear trains.	
UNIT-5	**CAMS**	**10**
	Types of cam, Types of follower. Displacement, Velocity and, Acceleration time curves for cam profiles. Disc cam with reciprocating follower having knife-edge, roller and flat-face follower, Disc cam with oscillating roller follower. Follower motions including SHM, Uniform velocity, uniform acceleration and retardation and Cycloidal motion	

COURSE OUTCOMES: On completion of the course, student should be able to;

1) Identify the types of Kinematic motion in machines used in everyday life.
2) Calculate the velocity and acceleration of linkages using graphical, analytical, and vector approaches.
3) Synthesize mechanisms for prescribed path and motion generation using graphical, analytical, and computational methods.
4) Design the cam profile for the desired follower motion for applications such as IC engine valves, machine tools.
5) Estimate the gear tooth parameters and train value for different types of gear trains.

TEXT BOOKS:

1. **"Theory of Machines",** Thomas Bevan
2. **"Theory of Machines",** Rattan S.S, Tata McGraw-Hill Publishing Company Ltd., New Delhi, and 3rd edition -2009.
3. **"Theory of Machines",** Sadhu Singh, Pearson Education (Singapore) Pvt. Ltd, Indian Branch New Delhi, 2nd Edi. 2006

REFERENCE BOOKS:

1. **"Theory of Machines & Mechanisms**", J.J. Uicker, G.R. Pennock, J.E. Shigley. OXFORD 3rd Ed. 2009.
2. **Mechanism and Machine theory**, Ambakar, PHI

   Graphical Solutions may be obtained either on the Graph Sheets or on the Answer Book itself.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)
(irrespective of portions covered due to whatever might be the reason)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	1	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : MANUFACTURING PROCESS – II		
Sub Code: ME44	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/week : 04
Exam Duration:3hours		Exam Marks : 100

COURSE OBJECTIVES:

1. To expose the students to a variety of manufacturing processes including their typical use and Capabilities.
2. To teach the students mechanical aspects of manufacturing processes, such as cutting force, tool life.
3. To provide students a technical understanding of common traditional processes and non-traditional processes to aid in appropriate process selection for the material and required tolerances.

#	Contents	h
UNIT-1	**INTRODUCTION**	10
	THEORY OF METAL CUTTING Single point cutting tool nomenclature, geometry. Mechanics of Chip Formation, Types of Chips. Merchants circle diagram and analysis, Ernst Merchant's solution, shear angle relationship, problems on Merchant's analysis. Tool Wear and Tool failure, tool life. Effects of cutting parameters on tool life. Tool Failure Criteria, Taylor's Tool Life equation. Problems on tool life evaluation. **CUTTING TOOL MATERIALS:** Desired properties and types of cutting tool materials – HSS, carbides, coated carbides, ceramics. Cutting fluids. Desired properties, types and selection. Heat generation in metal cutting, factors affecting heat generation. Heat distribution in tool and work piece and chip. Measurement of tool tip temperature.	
UNIT-2	**BASIC MACHINE TOOLS**	14
	TURNING (LATHE), SHAPING AND PLANING MACHINES Classification, constructional features of Turret and Capstan Lathe. Tool Layout, Shaping Machine, Planing Machine, Driving mechanisms of lathe, shaping and Planing machines, Different operations on lathe, shaping machine and Planing machine. Simple problems on machining time calculations. **DRILLING AND MILLING MACHINES** Classification, constructional features, drilling & related operations. Types of drill & drill bit nomenclature, drill materials, milling cutters nomenclature, milling operations, up milling and down milling concepts. Various milling operations. Indexing: Simple, compound, differential and angular indexing calculations. Simple problems on simple and compound indexing.	
UNIT-3	**GRINDING AND FINISHING PROCESSES**	14
	GRINDING Types of abrasives, Grain size, bonding process, grade and structure of grinding wheels, grinding wheel types. Classification, constructional features of grinding machines (Centerless, cylindrical and surface grinding). Selection of grinding wheel.Grindingprocess parameters. Dressing and truing of grinding wheels.	

	BROACHING- Principle of broaching. Details of a broach. Types of broaching machines-constructional details.Applications.Advantages and Limitations. **FINISHING PROCESSES:** Lapping and Honing operations – Principles, arrangement of set up and application. **SUPER FINISHING PROCESS:** Polishing, buffing operation and application	
UNIT-4	**FORGING**	08
	Classification of forging processes, forging machines and equipments.Expressions for forging pressures and load in open die forging and closed die forging by slab analysis, concept of friction hill and factors affecting it.Die-design parameters. Material flow lines in forging. Forging defects, Residual stresses in forging. Simple problems.	
UNIT-5	**NON-TRADITIONAL MACHINING PROCESSES**	06
	Classification, Mechanism of material removal, Principle of working, process parameters, process capabilities, application and limitations of ECM, EDM, WEDM and USM.	

COURSE OUTCOMES: On completion of the course, student should be able to;

1) Understand and analyze the effect of temperature, strain rate in metal working, heat affected zones and learn different tool materials.
2) Describe the different machining operations performed on lathe, shaping, planning, milling and drilling along with their features.
3) Differentiate finishing processes, know their capabilities and applications
4) Select different forging processes, machines, knowledge of die design parameters,. Analyze and calculate the forging pressure and load in open die forging and identify forging defects.
5) Differentiate different non-traditional machining processes based on the mechanism of material removal, working principle and analyze the process parameters of ECM, EDM, WEDM and USM.

TEXT BOOKS:

1. Workshop Technology, HajraChoudhry, Vol-II, Media Promoters& Pub. Pvt. Ltd. 2004
2. Production Technology, R.K.Jain, Khanna Publications, 2003.
3. Production Technology, HMT, Tata McGraw Hill, 2001.
5. Manufacturing Technology - Vol. 2, P N Rao, TMH Education; 3rdedition (1 May 2013)
6. Production Technology ,R.K.Jain, Khanna Publications, 2003.
7. Production Technology, P.C. Sharma, S Chand (1 December 2006)

REFERENCE BOOKS:

1. Manufacturing Science, AmitabhaGhosh and Mallik, affiliated East West Press, 2003.
2. Fundamentals of Metal Machining and Machine Tools, G.Boothroyd, McGraw Hill, 2000.

SCHEME OF EXAMINATION (SEE):

1. ONE FULL QUESTION from UNIT-1, UNIT-4 and UNIT-5 are COMPULSORY.
2. TWO FULL QUESTIONS with CHOICE from UNIT-2 and UNIT-3 ONLY.
3. MAXIMUM of THREE SUB-DIVISIONS in EACH FULL QUESTION

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	1	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : MATERIAL SCIENCE AND METALLURGY		
Sub Code: ME45	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/week : 03
Exam Duration:3hours		Exam Marks : 100

COURSE OBJECTIVES:

1. Know the fundamental science and engineering principles relevant to materials.
2. Understand the relationship between nano/microstructure, characterization, properties and processing and design of materials.
3. Have experimental skills for a professional career or graduate study in materials.
4. Possess a knowledge of the significance of research, the value of continued learning and environmental/social issues surrounding materials.
5. The student should be able to understand all basic principles involved in the theory of Elasticity and Plasticity.

#	Contents	h
UNIT-1	**CRYSTAL STRUCTURE**	**12**
	BCC, FCC and HCP Structures, coordination number and atomic packing factors, crystal imperfections -point line and surface imperfections. Atomic Diffusion: Phenomenon, Flick's laws of diffusion, factors affecting diffusion. Mechanical Behaviour**:** Stress-strain diagram showing ductile and brittle behaviour of materials, linear and non linear elastic behaviour and properties, mechanical properties in plastic range, yield strength offset yield strength, ductility, ultimate tensile strength, toughness. Plastic deformation of single crystal by slip and twinning.Metallography:Specimen preparation for metallographic study, study of metallurgical, transmission electron and scanning electron microscopes, etc.,	
UNIT-2	**DUCTILE AND BRITTLE FRACTURE**	**10**
	Modes of fracture :Type I, Type II and Type III. **CREEP:** Description of the phenomenon with examples, three stages of creep, creep properties, stress relaxation. **FATIGUE:** Types of fatigue loading with examples, Mechanism of fatigue, fatigue properties, fatigue testing and SN diagram. **SOLIDIFICATION**: Mechanism of solidification, Homogenous and Heterogeneous nucleation, crystal growth, cast metal structures. Solid solutions Hume Rothary rule, substitutional and interstitial solid solutions, intermediate phases, Gibbs phase rule.	
UNIT-3	**PHASE DIAGRAM**	**06**
	Construction of equilibrium diagrams involving complete and partial solubility, lever rule. Iron carbon equilibrium diagram description of phases, solidification of steels and cast irons, invariant reactions. **HEAT TREATING OF METALS:** Introduction, TTT curves, continuous cooling curves, annealing and its types,normalizing, hardening, tempering, martempering, austempering, hardenability, surface hardening methods like carburizing, cyaniding, nitriding, flame hardening and induction hardening, age hardening of aluminium-copper alloys (Process description, parameters, applications and limitations).	

UNIT-4	**FERROUS AND NON FERROUS MATERIALS**	**06**
	Properties, Composition and uses of Grey cast iron, malleable iron, Spheroidal Graphite iron and steel; Copper alloys-brasses and bronzes; Aluminium alloys-Al-Cu, Al-Si, Al-Zn alloys. **CORROSION:** Definition, various types, control and prevention, monitoring and measurements.	
UNIT-5	**COMPOSITE MATERIALS**	**05**
	General aspects, classification, properties, uses, characteristics, applications of composite materials, types of matrix materials & reinforcements, disadvantages, advantages and application of composites. **POLYMERS** ; Classification- Thermosets and thermoplastic, properties, applications. **SMART MATERIALS:** Introductionand properties of piezoelectric materials, shape memory alloys, ER and MR fluids, electrostrictive and magntostrictive materials as smart materials, applications.	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Understand the scientific and engineering principles underlying the four major elements of the field of Metallurgical and Materials Engineering, namely structure, properties, processing and performance related to materials systems appropriate to the field.
2. To design and conduct experiments according to ASTM standards and analyze the acquired data.
3. Know about the structure of a metal, be able to describe resultant elastic properties in terms of its 1D and 2D defects. Which material properties vary significantly with microstructure? Given a binary phase diagram, what microstructures can be obtained by suitable thermal treatments?
4. Understand about the driving forces and kinetic barriers to phase transformations. What are the governing factors for, fatigue and creep? Ductile and brittle fracture. How are the mechanical properties of a composite material related to the properties and arrangement of the component materials?

TEXT BOOKS:

1. **Foundations of Materials Science and Engineering,** Smith, 3rd Edition McGraw Hill, 2009
2. **Materials Science,** Shackleford and M. K. Muralidhara**,** Pearson Publication – 2007.
3. **Material Science ,**byCallister, Reprint 2008, Wiley India (P) LTD**.**
4. **Material Science** by V. Raghavan, Fifth Edition, PHI(P) LTD.
5. **Smart Material and Structures** by M.V. Gandhi and B.S. Thompson, First Edition 1992, Chapman& Hall.

REFERENCE BOOKS:

1. **Elements of Materials Scienceand Engineering,** H. Van Vlack
2. **Engineering Materials Science**, W.C. Richards, PHI, 1965.
3. **Physical Metallurgy**; Lakhtin, Mir Publications.
4. **Material Science and Engineering (SI Units),** R.K. Rajput
5. **Smart Materials and Structures,** M V Gandhi and B S Thompson Chapmen & Hall
6. **PHYSICAL METALLURGY : PRINCIPLES AND PRACTICE**, V. Raghavan,

SCHEME OF EXAMINATION (SEE):

1. ONE FULL QUESTION from UNIT-3, UNIT-4 and UNIT-5 are COMPULSORY.
2. TWO FULL QUESTIONS with CHOICE from UNIT-1 and UNIT-2 ONLY.
3. MAXIMUM of THREE SUB-DIVISIONS in EACH FULL QUESTION

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)
(irrespective of portions covered due to whatever might be the reason)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : MATERIAL TESTING LABORATORY		
Sub Code: MEL46	No of Credits : L-T-P-SS 00:00:02:00 =01	No. of lecture hours/week : 02
Exam Duration:3hours		Exam Marks : 50

COURSE OBJECTIVES:

1) To focus on the standards to be followed for mechanical properties estimation
2) To understand the need for the methods of mechanical properties testing
3) To know the salient steps in preparing test coupons for microstructure study
4) To get a peek into the non-destructive testing

#	Contents	h
UNIT-1	**INTRODUCTION TO ASTM STANDARDS FOR TESTING OF MATERIALS**	**18**
	Tensile, shear and compression tests of metallic and non metallic specimens using Universal Testing Machine, Torsion Test, Bending Test on metallic and nonmetallic specimens, Fatigue Test, Izod and Charpy Tests on M.S,C.I Specimen, Brinell, Rockwell and Vickers's Hardness test.	
UNIT-2	**PREPARATION OF SPECIMEN FOR METALLOGRAPHIC EXAMINATION OF DIFFERENT ENGINEERING MATERIALS**	**08**
	Identification of microstructures and grain size count of plain carbon steel, tool steel, gray C.I, SG iron, Brass and Bronze & composites. To study the defects of Cast and Welded specimens using Non-destructive test experiments like, (a) Ultrasonic flaw detection (b) Magnetic crack detection (c) Dye penetration testing equipment, microstructure studies of composites	

COURSE OUTCOMES: On completion of the course, student should be able to;

1) Familiarize with the standards for mechanical properties estimation
2) Validate the need for mechanical properties testing
3) Conversant with preparing test coupons for microstructure study
4) Acquaint with non-destructive testing

REFERENCE BOOKS:

1. "Mechanical Metallurgy"**, George E Dieter, McGraw Hill Publications, 1986.**
2. "Strength of Materials", **S.S. Rathan, Tata McGraw Hill Publications, Second Edition**

CONTINUOUS INTERNAL EVALUATION (CIE)

1. CIE has a maximum of 50 marks i.e., Evaluation of Record (30) + Test (20)
2. CIE Marks is finalized by conducting ONE test at the end of 10th week of the semester.

SCHEME OF EXAMINATION (SEE):

ONE question from Part A	:	25 Marks
ONE question from Part B	:	15 Marks
Viva-Voce	:	10 Marks
Total	:	50 Marks

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : MANUFACTURING PROCESS LABORATORY - II		
Sub Code: MEL47	No of Credits : L-T-P-SS 00:00:02:00 =01	No. of lecture hours/week : 02
Exam Duration:3hours		Exam Marks : 50

COURSE OBJECTIVES:

1. To teach the students to produce simple work pieces using different machines such as lathe, shaping, milling and drilling.

#	Contents	h
UNIT-1	**TURNING MACHINE**	**18**
	Preparation of three models on lathe involving Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning.	
UNIT-2	**MILLING MACHINE**	**09**
	Cutting of V Groove/ dovetail / Rectangular groove using a shaper / milling machine Cutting of Gear Teeth using Milling Machine	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Identify machines and usage of machine tools
2. Demonstrate setting of work piece into different machines.
3. Analyze and utilize tools in machining different workpieces and then with care to load and unload workpieces as per the set dimensions.
4. Demonstrate simple operations on a lathe, milling, drilling and shaping machines

CONTINUOUS INTERNAL EVALUATION (CIE)

1. CIE has a maximum of 50 marks.
2. CIE Marks is finalized by conducting a test at the end of 10^{th} week of the semester.
3. CIE Marks (50) = Evaluation of Record (30) + Test (20)

REFERENCE BOOKS:

1. Production Technology, R.K.Jain, Khanna Publications, 2003.
2. Production Technology, HMT, Tata McGraw Hill, 2001.
3. Manufacturing Technology - Vol. 2, P N Rao,TMH; Third edition (1 May 2013)
4. Production Technology ,R.K.Jain, Khanna Publications, 2003.
5. Production Technology, P.C. Sharma, S Chand (1 December 2006)

SCHEME OF EXAMINATION (SEE):

1.	One Compulsory Model from PART A	20 marks
2.	One optional Model from PART B	20 marks
3.	Viva – Voce	10 marks
	TOTAL	50 marks

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : FLUID MECHANICS AND MACHINES LABORATORY		
Sub Code: MEL48	No of Credits : L-T-P-SS 00:00:02:00 =01	No. of lecture hours/week : 02
Exam Duration:3hours		Exam Marks : 50
Pre-requisites	Fluid Mechanics, Turbomachines	

COURSE OBJECTIVES:

1. To conduct experiment to determine coefficient of impact of water jet on vanes.
2. To determine coefficient of discharge of orifice meter, venturimeter and V-notch.
3. To conduct experiment to determine minor and major loss of head in flow through a pipe.
4. To conduct performance test on Pelton, Francis and Kaplan turbines and evaluate the efficiency of these turbines.
5. To determine the efficiency of single stage and multi stage centrifugal pump and plot the characteristic curves.
6. To conduct performance test on reciprocating pump and determine the percentage slip.

#	Contents	h
UNIT-1	**MINOR EXPERIMENT**	**12**
	1) Impact of jet on vanes - Determination of coefficient of impact of water jet on flat vane, inclined vane and hemispherical vane. 2) Orifice meter – Determination of coefficient of discharge (Calibration of orifice meter) 3) Venturimeter – Determination of coefficient of discharge (Calibration of venturimeter) 4) V- notch – Determination of coefficient of discharge (Calibration of V notch) 5) Flow through a pipe - Determination of major losses. 6) Flow through a pipe - Determination of minor losses.	
UNIT-2	**MAJOR EXPERIMENT**	**12**
	I. Performance testing, plotting the characteristic curves and determination of unit quantities and specific speed of 1) Pelton turbine 2) Francis turbine 3) Kaplan turbine **II.** Performance testing, plotting the characteristic curves and determination of specific speed of 4) Single stage centrifugal pump 5) Multi stage centrifugal pump **III.** Coefficient of discharge and percentage slip of a 6) Reciprocating pump	

REFERENCE BOOKS

1) **Hydraulics and Fluid Mechanics including Hydraulic Machines**, Dr. P.N. Modi and S.M. Seth, Rajsons Publications Private Limited, Standard Book House, 2009.

SCHEME OF EXAMINATION (SEE)

Sl. No.	Particulars	Max. Marks	Break Up of Max. Marks		
			Write Up	Conduction of experiment	Specimen Calculation, Tabulation of Results and Plotting of Graph
1	Unit-1: Minor Experiment (Any one from the list of experiments)	**15**	05	05	05
2	Unit-2: Major Experiment (Any one from the list of experiments)	**25**	05	10	10
3	Viva Voce	**10**	—	—	—
	TOTAL MARKS	**50**	**10**	**25**	**15**

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Describe fluid properties and classify them.

2. Calibrate different types of flow measurement devices.

3. Understand the general working of fluid machines.

4. Describe the functioning of radial flow and axial flow fluid machines

5. Derive various equations related to the performance of turbo machines.

6. Analyze and predict the performance of various turbo machines.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	2	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	1	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	2	1	1	1	1	1	1	2	1	1
6	3	3	2	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

SYLLABUS

2016-17

Department of
Mechanical Engineering
5th and 6th Semester

Dr. AMBEDKAR INSTITUTE OF TECHNOLOGY
(An Autonomous Institution, Affiliated to VTU, Belagavi)
Near JnanaBharathi Campus, BDA Outer Ring Road,
Mallathahalli, Bengaluru – 560056

Dr. AMBEDKAR INSTITUTE OF TECHNOLOGY
BANGALORE - 56
AIDED BY GOVERNMENT OF KARNATAKA
&
AN AUTONOMUS INSTITUTION AFFILIATED TO VTU, BELGAVI

Vision

- To create Dynamic, Resourceful, Adept and Innovative Technical professionals to meet global challenges.

Mission

- To offer state-of-the-art undergraduate, postgraduate and doctoral programs in the fields of Engineering, Technology And Management
- To generate new knowledge by engaging faculty and students in research, development and innovation.
- To provide strong theoretical foundation to the students, supported by extensive practical training to meet the industry requirements.
- To instill moral and ethical values with social and professional commitment.

SCHEME AND SYLLABUS FOR ADMISSION BATCH 2014-15

FOR 2014 BATCH - 5th SEMESTER			L	T	P	C
1	HS03**	MANAGEMENT & ENTREPRENEURSHIP	4	0	0	4.0
2	ME51	DESIGN OF MACHINE ELEMENTS- I	4	0	0	4.0
3	ME52	DYNAMICS OF MACHINES	4	0	0	4.0
4	ME53	HEAT TRANSFER	4	0	0	4.0
5	ME54	COMPUTER AIDED DESIGN & MANUFACTURING	4	0	0	4.0
6	ME551	EXPERIMENTAL STRESS ANALYSIS	3	0	0	3.0
	ME552	ADVANCED MACHINING PROCESSES	3	0	0	3.0
	ME553	POWER PLANT ENGINEERING	3	0	0	3.0
7	MEL56	HEAT TRANSFER LABORATORY	0	0	2	1.0
8	MEL57	FUEL TESTING & INTERNAL COMBUSTION ENGINES LABORATORY	0	0	2	1.0
		FIFTH SEMESTER TOTAL CREDITS				25.0

FOR 2014 BATCH -6rd SEMESTER			L	T	P	C
1	IDE	INTER-DEPARTMENTAL ELECTIVE	4	0	0	4.0
2	ME61	DESIGN OF MACHINE ELEMENTS-II	4	0	0	4.0
3	ME62	FINITE ELEMENT METHOD	4	0	0	4.0
4	ME63	MECHANICAL VIBRATIONS	4	0	0	4.0
5	ME64	OPERATIONS RESEARCH	4	0	0	4.0
6	ME651	THEORY OF ELASTICITY	3	0	0	3.0
	ME652	COMPOSITE MATERIALS AND MANUFACTURING	3	0	0	3.0
	ME653	HEATING, VENTILATION & AIR CONDITIONING	3	0	0	3.0
7	MEL66	COMPUTER INTEGRATED MANUFACTURING LABORATORY	0	0	2	1.0
8	MEL67	DESIGN LABORATORY	0	0	2	1.0
9	MEP68	MINI PROJECT WORK	0	0	4	2.0
		SIXTH SEMESTER TOTAL CREDITS				27.0
		THIRD YEAR TOTAL CREDITS				52.0
		CUMULATIVE CREDITS				152.0

V SEMESTER

Sub Title: MANAGEMENT AND ENTREPRENEURSHIP		
Sub Code: HS03	No of Credits :4= 4: 0: 0(L-T-P)	No of lecture hours/week :4
Exam Duration:3hours	CIE + Assignment + SEE =45 + 5 + 50=100	Total no of contact hours:52

COURSE OBJECTIVES:

1. To Help Students Understand The Concepts Of Management And Develop Managerial Skills
2. To Have A Clear Understanding Of The Activities Involved In Establishing A Business Venture

Unit No	Syllabus contents	No of Hours
1	**MANAGEMENT:** Introduction-meaning-nature and characteristics of management, scope and functional area of management, management as a science or art of profession, management and administration, roles of management, levels of management, Development of management thought -Early management approaches, Modern management approaches.	10
2	**PLANNING, ORGANIZING, DIRECTING AND CONTROLLING:** **PLANNING:** Meaning and Nature, Types of Plans and Steps in Planning process. **ORGANIZING:** as Managerial function – Nature and purpose of organization, principles of organization, types of organization. Departmentation, committees, Centralization Vs Decentralization of authority and responsibility, span of control, MBO and MBE (Meaning only) Staffing: Nature and importance of staffing, process of selection and recruitment (in brief). Decision Making Process. **DIRECTING:** Meaning and nature of directing, leadership styles, motivation theories, Communication – meaning and importance **CO-ORDINATION:** Meaning and importance of Coordination, techniques of co-ordination. **CONTROLLING:** Meaning and steps in controlling-Essentials of a sound control system-Methods of establishing control (in brief), Control functions in Management, Types of Control – feed forward, concurrent and feedback controls, Factors in control effectiveness.	12
3	**ENTREPRENEUR**: Meaning, evolution of the concept, functions of an entrepreneur, types of entrepreneur, Intrapreneur – an emerging class. Concept of entrepreneurship, Evolution of entrepreneurship, development of entrepreneurship, Stages in entrepreneurial process, Role of entrepreneurs in economic development, entrepreneurship in India, entrepreneurship-its barriers.	08
4	**SMALL SCALE INDUSTRY**: Definition; Characteristics; Need and rationale: Objectives, Scope and role of SSI in economic Development, Advantages of SSI, Steps to start an SSI, Government Policy towards SSI; Government support for SSI during Five years plans, Impact of Liberalization, Privatization Globalization on SSI, Effect of WTO/GATT. Ancillary Industry and Tiny Industry (definition only). **SUPPORTING AGENCIES OF GOVERNMENT FOR SSI:** Meaning Nature of support; Objectives, function, Types of Help. **INSTITUTIONAL SUPPORT:** Different Schemes, KIADB, KSSIDC, KSIMC DIC Single Window agency SISI NSIC SIDBI, KSFC.	12
5	**PREPARATION OF PROJECT:** Meaning, Project identification, Project selection, Project Report - Need and Significance of Project, Contents: formulation: Guidelines by Planning Commission for Project report, Network Analysis, Errors of project report, Project Appraisal, Identification of Business Opportunities. Feasibility Study-Market Feasibility Study, Technical Feasibility Study, Financial Feasibility Study, Social Feasibility Study.	10

<u>Note1</u>: Unit 2 & Unit 4 will have internal choice
<u>Note2</u>: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES:

CO1 : Students would be able to analyze the importance of management concepts
CO2 : Students will get an in depth knowledge in entrepreneurship and its importance in emerging India

COs	**Mapping with POs**
CO1	PO8,PO9,PO10,PO11,PO12
CO2	PO8,PO9,PO10,PO11,PO12

Text Books:

1) **Principles of Management** , PC Tripathi, and P N Reddy , Tata MacGraw Hill.
2) **Entrepreneurship and Management**, S Nagendra and V S Manjunath , Pearson Publication ,4th Edition, 2009.
3) **Management and Entrepreneurship** , NVR Naidu and T Krishna Rao, I K International Publishing House PVT LTD .

Reference Books:

1. **Dynamics of Entrepreneurial Development and Management**,Vasant Desai,Himalaya Publishing House.
2. **Entrepreneurship Development** , Poornima M Charanthimath ,Pearson Education ,2006.

CHAIRMAN/BOS DEAN (ACADEMIC) CHAIRMAN/ACADEMIC COUNCIL

V Semester (2014-15)

COURSE TITLE : DESIGN OF MACHINE ELEMENTS – I		
Sub Code: ME51	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/week : 04
Exam Duration:3hours		Exam Marks : 100

COURSE OBJECTIVES:

This course "Design of Machine Elements -1" is designed with the following objectives in mind:

1. The student shall understand the design function, basic principles, steps involved and its relation manufacturing.
2. To acquaint with the concepts of strength design related to various components and understand various type of standard material standard and CODES to choose suitable materials for the different machine elements depending on their, availability, Cos and, properties. Choose suitable Factor of safety (FOS) and factors to be consider while selecting suitable Factor of safety (FOS) for the design depending on their application..
3. The student shall gain a thorough understanding of the different types of failure modes and criteria. He will be conversant with various failure theories and be able to judge which criterion is to be applied in different situations.
4. Student shall gain design knowledge of the different types of elements used in various machine design process. e.g., fasteners (temporary and permanent fasteners) such as shafts, couplings Riveted and Welded joints etc. and will be able to design these elements for depending on different loads forvarious suitable applications.

#	Contents	h
UNIT-1	**INTRODUCTION**	**14**
	Introduction to machine design, Classification, materials and their properties, Design considerations: Codes and standards, Stress-strain diagrams, Stress analysis, Definitions: normal, shear, bi-axial and tri axial stresses, Stress tensor, Principal Stresses and their directions, Shear stress and their directions. **DESIGN FOR STATIC STRENGTH:** Static loads and factor of safety, Theories of failure: Maximum normal stress theory, Maximum shear stress theory, Maximum strain theory, Strain energy theory, Distortion energy theory. Failure of brittle and ductile materials, Stress concentration, Determination of Stress concentration factor. Stress concentration charts, stress concentration and static loads and compound stress concentration factors.	
UNIT-2	**DESIGN FOR FATIGUE STRENGTH**	**08**
	Introduction- S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit, Modifying factors: size effect, surface effect, Stress concentration effects, Fluctuating stresses, Goodman and Soderberg relation, stresses due to combined loading, cumulative fatigue damage. **IMPACT STRENGTH:** Introduction, Impact stresses due to axial, bending and torsional loads, effect of inerti	

UNIT-3	**DESIGN OF SHAFTS**	**08**
	Torsion of shafts, design for strength and rigidity with steady loading, ASME codes for power transmission shafting, shafts under fluctuating loads and combined loads. **KEYS:** Types of keys, Design of keys	
UNIT-4	**JOINTS**	**14**
	RIVETED JOINTS Types, rivet materials, failures of riveted joints, Joint Efficiency, Boiler Joints, Lozenge Joints, Riveted Brackets, Eccentrically riveted joints. **WELDED JOINTS** Types, Strength of butt and fillet welds, eccentrically loaded welded joints	
UNIT-5	**COUPLINGS**	**08**
	Introduction, classification, advantages, and applications of Couplings: design of Rigid and flexible couplings, Flange coupling, Bush and Pin type coupling and Oldham's coupling.	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Demonstrate ability to use free-body diagrams, equilibrium, force, moment and torque equations diagrams, and calculate resulting stresses.
2. Identify relevant properties of materials from various sources and apply basic principles of machine design to compute principal stresses in different machine members coursed to combined loadings.
3. Demonstrate the ability to calculate various stresses stress concentration, fatigue loading fatigue stress concentration, for variable loading conditions
4. Express ability to apply stress and deflection analyses, failure criteria under steady and variable loadings, in applications involving the design of simple machine elements, (temporary and permanent fasteners) such as shafts, couplings Riveted and Welded joints etc. and will be able to design these elements for depending on different loads for various suitable applications. Thus he shall be able to apply the knowledge of machine design in real life usage to meet / satisfies the industrial needs

TEXT BOOKS:

1. **Mechanical Engineering Design,** Joseph E Shigley and Charles R. Mischke. McGraw Hill International edition, 6th Edition 2009.
2. **Design of Machine Elements,** V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2007.

DESIGN DATA HANDBOOK:

1. **Design Data Hand Book,** K. Lingaiah, McGraw Hill, 2nd Ed.
2. **Data Hand Book,** K. Mahadevan and Balaveera Reddy, CBS Publication
3. **Design Data Hand Book,** H.G. Patil, ShriShashiPrakashan, Belgaum.

REFERENCE BOOKS:

1. **Machine Design,** Robert L. Norton, Pearson Education Asia, 2001.
2. **Design of Machine Elements,** M. F. Spotts, T. E. Shoup, L. E. Hornberger, S. R. Jayram and C. V. Venkatesh, Pearson Education, 2006.
3. **Machine Design,** Hall, Holowenko, Laughlin (Schaum's Outlines series) Adapted by S.K. Somani, Tata McGraw Hill Publishing Company Ltd., New Delhi, Special Indian Edition, 2008.
4. **Fundamentals of Machine Component Design,** Robert C. Juvinall and Kurt M Marshek, Wiley India Pvt. Ltd., New Delhi, 3rd Edition, 2007.

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven Full Questions to be set.
2. Five full Questions to be answered.
3. Unit-2, Unit-3 and Unit-5 are compulsory, with one question from each Unit.
4. Unit-1 and Unit-4: Two questions to be set with choice.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	3	2	2	3	2	3	1	3	3
CO2	2	3	3	2	3	3	3	1	2	3	3	2
CO3	3	3	2	3	3	3	1	3	3	2	3	2
CO4	3	3	2	3	3	2	3	2	1	2	3	3

- **High-3**
- **Medium-2**
- **Low-1**

COURSE TITLE : DYNAMICS OF MACHINES		
Sub Code: ME52	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/week : 04
Exam Duration:3hours		Exam Marks : 100
Pre-requisites	Engineering Physics, Engineering Mathematics	

COURSE OBJECTIVES:

1. Draw and analyze free body diagram for multiple forces applied on static members of four bar chain and slider mechanism. And esign the size of the flywheel for the excess energy storage and retrieval.
2. Define the terms slip and creep in belt drives andEvaluate power transmitted and condition for maximum power transmission.
3. Determine the value of balancing mass for the system.
4. Define sensitivity, isochronous, hunting, controlling force with respect to governors and Analyses the effect of gyro on automobile, ship, Aero plane and rotating members.
5. Evaluate the velocity and acceleration of the follower on cams having specified contours

#	Contents	h
UNIT-1	**FORCE ANALYSIS**	12
	STATIC FORCE ANALYSIS Introduction: Static equilibrium. Equilibrium of two and three force members.Members with two forces and torque. Free body diagrams. Principle of virtual work.Static force analysis of four bar mechanism and slider-crank mechanism with and without friction. **DYNAMIC FORCE ANALYSIS:** D'Alembert's principle, Inertia force, inertia torque. Dynamic force analysis of four-bar mechanism and slider crank mechanism. Dynamically equivalent systems.Turning moment diagrams and flywheels.Fluctuation of Energy.Determination of size of flywheels.	
UNIT-2	**FRICTION AND BELT DRIVES**	08
	Definitions: Types of friction: laws of friction, Friction in pivot and collar bearings. Belt drives: Flat belt drives, ratio of belt tensions, centrifugal tension, power transmitted and V-belt drives-derivation and numerical problems.	
UNIT-3	**BALANCING OF ROTATING MASSES**	10
	Static and dynamic balancing.Balancing of single rotating mass by balancing masses in same plane and in different planes.Balancing of several rotating masses by balancing masses in same plane and in different planes.	
UNIT-4	**BALANCING OF RECIPROCATING MASSES**	10
	Inertia effect of crank and connecting rod, single cylinder engine, balancing in multi cylinder-inline engine (primary & secondary forces), V-type engine; Radial engine – Direct and reverse crank method	

UNIT-5	GOVERNORS	12
	Types of governor; force analysis of Porter and Hartnell governors. Controlling force curves. Requirements of characteristics of governor. Gyroscope**:** Introduction and gyroscopic couple. Effect of gyroscopic couple on ship, plane disc, aero plane, stability of two wheelers and four wheelers.	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Define the terms slip and creep in belt drives.
2. Discuss free body diagram for multiple forces applied on static members of four bar chain and slider mechanism.
3. Illustrate the terms slip and creep in belt drives.
4. Analyze the effect of gyro on automobile, ship, Aeroplane and rotating members.
5. Design the flywheel for the excess energy storage and retrieval.and Evaluate the velocity and acceleration of the follower on cams having specified demonstrate the Equilibrium of Two, Three and Four force members

TEXT BOOKS:

1. **Theory of Machines**, Rattan S.S. Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition, 2009.
2. **Theory of Machines**, Sadhu Singh, Pearson Education. 2nd edition. 2007.

REFERENCE BOOKS:

1. **Theory of Machines & Mechanisms,** J.J. Uicker, G.R. Pennock, J.E. Shigley. Oxford 3rd edition. 2009
2. **Mechanism and Machine Theory**, A.G. Ambekar PHI, 2007.

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven full Questions to be set.
2. Five full Questions to be answered.
3. Unit-2, Unit-3 and Unit-4 are compulsory, with one full question from each Unit.
4. Unit-1 and Unit-5: Two full questions to be set with choice

REMINDER:

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)
(Irrespective of portions covered due to whatever might be the reason)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : HEAT TRANSFER		
Sub Code: ME53	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/week : 04
Exam Duration:3hours		Exam Marks : 100
Pre-requisites	Basic Thermodynamics, Fluid Mechanics	

COURSE OBJECTIVES:

1. To outline the basic concepts of conduction, convection and radiation heat transfer. This course helps students to derive generalized expression for heat conduction equation.
2. To discuss and illustrate the application of various boundary conditions giving heat transfer examples.
3. To understand the unsteady heat conduction and convection heat transfer and apply the knowledge to solve real time problems.
4. To demonstrate the use of graphical charts for solving analytical problems.
5. To design heat exchangers based on the input variables such as inlet temperature of hot and cold fluids.
6. To evaluate various heat transfer parameters and predict the rate of heat transfer and heat transfer coefficients.

#	Contents	h
UNIT-1	**BASIC CONCEPTS AND CONDUCTION HEAT TRANSFER**	10
	Introduction - Modes of heat transfer, Basic laws, Combined heat transfer mechanism, Resistance concept, Boundary conditions of 1st, 2nd and 3rd kind; Thermal contact resistance; Overall heat transfer coefficient; Illustrations of applying the boundary conditions to heat transfer problems; Derivation of general equation of heat conduction in Cartesian coordinates; Special cases; Discussion on 3-D conduction in cylindrical and spherical coordinate systems (No derivation);Steady state heat conduction in simple and composite slabs, cylinders and spheres (uniform thermal conductivity and without heat generation); Introduction to extended surfaces; Derivation of heat transfer and temperature distribution in fins (uniform cross-section without heat generation); Long fin, short fin with insulated tip and without insulated tip and fin connected between two heat sources; Fin efficiency and effectiveness; Numericals	
UNIT-2	**ONE-DIMENSIONAL UNSTEADY CONDUCTION HEAT TRANSFER**	10
	Introduction; Conduction in solids with negligible internal temperature gradient (Lumped system analysis), Use of Transient temperature charts (Heisler's charts) for transient conduction in slab, long cylinder and sphere; use of transient temperature charts for transient conduction in semi-infinite solids. Related numericals.	
UNIT-3	**CONVECTION HEAT TRANSFER**	08
	Introduction – Boundary layer concept in external and internal flow; Forced Convection - Dimensional analysis for forced convection; Physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers; Use of correlations for flow over simple geometries (flat plate, cylinder and sphere); Use of correlations for flow inside a duct;Related numerical problems; Free or natural convection - Dimensional analysis for free convection; Physical significance of Grashofnumber; Use of correlations of free convection over flat plates (vertical, horizontal and inclined), cylinders (vertical and horizontal) and spheres; Related numericals.	

UNIT-4	HEAT EXCHANGERS	12
	Introduction; Classification of heat exchangers; Compact, Shell-and-tube and Plate heat exchangers; Overall heat transfer co-efficient and fouling factor; Parallel and counter flow heat ex-changers; Use of LMTD; Cross flow heat exchangers; Compari-son of parallel and counter flow heat exchangers; Heat transfer with phase change; Multi pass heat exchangers; Effectiveness-NTU method; Limiting cases; Heat transfer enhancement in fins; Related numerical problems; Heat pipes – Introduction; Work-ing principle; components; Applications; Limitations	
UNIT-5	**RADIATION HEAT TRANSFER**	**12**
	Introduction; Black bodies separted by a non-absorbing medium; Shape factor; Electrical analogy; Two black surfaces connected by non-conducting and re-radiating walls; Evaluation of shape factor; Radiation heat transfer between gray bodies; Radiosity and Irradiation; Radiation network for gray surfaces exchanging energy; Hottel's crossed string method; Radiation shields; Radiation from cavities; Radiation from Gases and vapours; Radiation combined with converction; Green house effect; Solar radiation.	

TEXT BOOKS

1. **Heat and Mass Transfer,** P.K. Nag, 3rd Edition, Tata McGraw-Hill Publications, 2011.
2. **A Course in Heat and Mass Transfer,** Domkundwar, Arora, Domkundwar, DhanpatRai Publications, 2005.

REFERENCE BOOKS

1. **Heat and Mass Transfer: Fundamentals and Applications**, Cengel,Y.A., and Ghajar, A.J., 5th Edition, McGraw-Hill Publications (SIE), 2015.
2. **Principles of Heat and Mass Transfer**, Frank P. Incropera, David P. Dewitt, Theodore L. Bergman, and Adrienne S. Lavine, 7th Edition, Wiley Student Edition, 2013.

e-LEARNING RESOURCES

1. **A Heat Transfer Text Book**, John H Leinard IV and John H Leinard V, 3rd Edition, Phlogiston Press, Cambridge, Massachusetts, USA, 2008.
2. **Heat and Mass Transfer: Mechanical Engineering Handbook**, Kreith, F., Boehm, R.F., et. al., Frank Kreith (Ed), Boca Raton: CRC Press LLC, 1999.
3. **Fundamentals of Heat and Mass Transfer**, Frank P. Incropera, David P. Dewitt, et. al. Frank P. Incropera (Ed), 6th Edition, John Wiley and Sons, 2007.
4. **e-Journal: Frontiers in Heat and Mass Transfer**, http://www.ThermalFluidsCentral.org
5. **Videos, Student slides, Handouts, Lecture notes:** http://www.nptel.ac.in

DATA HAND BOOK AND CHARTS

1. **Heat and Mass Transfer Data Hand Book,** C.P. Kothandaraman, S. Subramanyan, New Age International Publishers, 8th Edition, 2014.
2. **Steam Tables with Mollier Diagram: SI Units**, Mahesh M.Rathore, DhanpatRai Publishing Company, 2014.

SYLLABUS COVERAGE FOR CIE

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)
CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES: On completion of the course, student should be able to;

After completion of the course, students will be able to:

1. Identify the different modes of heat transfer and state the laws related to each of them.
2. Explain the various modes of heat transfer and heat transfer devices with ex-amples and illustrations.
3. Solve numerical problems related to different modes of heat transfer and heat transfer devices.
4. Compare and analyse different modes of heat transfer.
5. Derive expressions for determining the heat transfer rate during steady and un-steady state conduction, convection and radiation modes.
6. Calculate the rate of heat transfer in different modes of heat transfer and com-pute the performance of various heat transfer systems.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : COMPUTER AIDED DESIGN AND MANUFACTURING		
Sub Code: ME54	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/week : 04
Exam Duration:3hours		Exam Marks : 100

COURSE OBJECTIVES:

1. To teach the role of CAD/CAM in modern design and manufacturing
2. To impart the use of CAD in the design process
3. To impart the use of CAM in the production preparation process
4. Demonstrate the applications and limitations of different CAD/CAM system types

#	Contents	h
UNIT-1	**INTRODUCTION**	**10**
	Role of computers in design and manufacturing influence of computers in manufacturing environment.Product cycle in convention to computerized manufacturing environment.Introduction to CAD.Introduction to CAM.Advantages and disadvantages of CAD and CAM, curves and types.	
UNIT-2	**STANDARD EXCHANGE FORMAT AND TRANSFORMATION**	**10**
	Software configuration of a graphic system. Function of graphics package, construction of geometry, wire frame and solid modeling, CAD/CAM integration. Desirable modeling facilities, Introduction to exchange of modeling data – Basic features of IGES, STEP, DXF, DMIS.	
UNIT-3	**NC, CNC, DNC TECHNOLOGIES:**	**12**
	NC, CNC, DNC, modes. NC element, advantages and limitations of NC, CNC.Functions of computer in DNC. CNC tooling: Turning tool geometry, milling tooling system, tool presetting. ATC, work holding, APT programming	
UNIT-4	**CNC MACHINING CENTERS**	**12**
	Introduction to CNC, elements of CNC, CNC machining centers, part programming, fundamental steps involved in development of part programming for milling and turning	
UNIT-5	**INTRODUCTION TO ROBOTICS**	**08**
	Introduction, robot configuration, robot motion, programming of robots, end effectors work cell, control and interlock, sensor, robot applications. Kinematic Analysis – Direct and Inverse Kinematic analysis, problems.	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Understand the possible applications of the CAD/CAM systems in structure analysis, optimize and virtual engineering.
2. Demonstrate the basic fundamentals that are used to create , manipulate and analyse geometric models in a computer graphics.
3. Explain the basic concepts, features of NC, CNC, DNC machines and machining centers.
4. To learn about Robot motions, sensors, end effectors Programming , kinematic analysis of robot

REFERENCE BOOKS

1. **Computer aided design (CAD) and computer aided manufacturing (CAM)** by MikellGroover, Pearson Education INC, Fifth Impression, 2008.
2. **CAD/CAM** by P N Rao, Tata McGraw Hill, Sixth Reprint, 2006.
3. **CAD/CAM** by Ibrahim Zied, Tata McGraw Hill, Fourth Reprint, 2008.

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven Full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-2 and Unit-5 are compulsory, with one question from each Unit.
4. Unit-3 and Unit-4: Two questions to be set with choice.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : EXPERIMENTAL STRESS ANALYSIS (CORE ELECTIVE)		
Sub Code: ME551	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/week : 03
Exam Duration:3hours		Exam Marks : 100

COURSE OBJECTIVES:

1. Analyze stresses within the elastic range in 3D.
2. Compile strains and displacements.
3. Evaluate stress and strain relations for linear elastic materials.
4. Demonstrate the experimental methods for analyzing stresses and strains in given specimen.
5. Develop photo-elastic, Moire techniques and holography methods for analyzing stresses experimentally.

#	Contents	h
UNIT-1	**ELECTRICAL RESISTANCE STRAIN GAUGES**	10
	Gauged factors &Strain sensitivity in metallic alloys, Gauge construction, characteristics of strain gauges,Adhesives and mounting techniques, Gauge sensitivity and gauge factor, Performance Characteristics, Environmental effects, Strain Gauge circuits. Wheatstone's Potentiometer bridges, Constant current strain gauge circuits. Method of mounting a strain gauge. **STRAIN ANALYSIS METHODS:** Two element, three element rectangular and delta rosettes, stress-strain relations, correction for transverse strain effects, method of mounting the strain gauges, Elimination of moment and torque in rosettes.	
UNIT-2	**PHOTOELASTICITY**	07
	Nature of light, Wave theory of light - optical interference, Stress optic law – effect of stressed model in plane and circularpolariscopes, Isoclinics&Isochromatics, Fringe order determination, determination of fractional fringe order (Tardy's compensation), photoelastic model materials.	
UNIT-3	**TWO DIMENSIONALPHOTOELASTICITY**	06
	Separation methods: Shear difference method, Analytical separation methods, Model to prototype scaling, Properties of 2D photoelastic model materials, Materials for 2D photoelasticity.	
UNIT-4	**PHOTOELASTIC(BIREFRINGENT) COATINGS**	10
	Birefringence coating stresses, Effects of coating thickness: Reinforcing effects, Poission's, Stress separation techniques: Oblique incidence, Strip coatings. **MOIRE METHODS:** Moire fringes produced by mechanical interference. Geometrical approach, Displacement field approach to Moire fringe analysis, out of plane displacement measurements, Out of plane slope measurements and Applications and advantages.	
UNIT-5	**BRITTLE COATINGS**	06
	Coatings stresses, Crack patterns, Refrigeration techniques, Load relaxation techniques, Crack detection methods, Types of brittle coatings, Calibration of coating. Advantages and brittle coating applications.	

COURSE OUTCOMES:

1. Analyze stresses within the elastic range of materials.
2. Compile strains and displacements
3. Evaluate stress and strain relations for linear elastic materials.
4. Describe the importance of experimental methods in analyzing stress and strain
5. Describe photo elastic, Moiré technique and holographic methods of experimental stress analysis Validate results with experiments

TEXT BOOKS:

1. **"Experimental Stress Analysis",** Dally and Riley, McGraw Hill.
2. **"Experimental Stress Analysis".** Sadhu Singh, Khanna publisher.
3. **Experimental stress Analysis**, Srinath L.S tataMcGraw Hill.

REFERENCES BOOKS :

1. **"PhotoelasticityVol I and VolII,**M.M.Frocht, John Wiley & sons.
2. **"Strain Gauge Primer",** Perry and Lissner,
3. **"Photo Elastic Stress Analysis",** Kuske, Albrecht & Robertson John Wiley & Sons.
4. **"Motion Measurement and Stress Analysis",** Dave and Adams.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven Full Questions to be set.
2. Five full Questions to be answered.
3. Unit-2, Unit-3 and Unit-5 are compulsory, with one question from each Unit.
4. Unit-1 and Unit-4: Two questions to be set with choice.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	2	0	1	0	1	0	3	1	3	0
2	2	3	2	2	1	0	3	0	3	1	3	0
3	3	3	2	3	3	0	3	0	3	2	3	2
4	0	0	2	1	3	1	2	0	2	2	2	2
5	0	0	0	2	2	1	2	1	2	1	2	2

Strong-3, Medium-2, Weak-1

COURSE TITLE : ADVANCED MACHINING PROCESSES (CORE ELECTIVE)		
Sub Code: ME552	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/week : 03
Exam Duration:3hours		Exam Marks : 100

COURSE OBJECTIVES:

1. To gain theoretical and practical knowledge in material casting processes and develop an understanding of the dependent and independent variables which control materials casting in a production setting.
2. Introduce students to good foundry practices and product design considerations.
3. This course covers fundamentals of machining processes using traditional machine tools: lathe, milling machine, and cutoff saw.
4. An in-depth coverage of shop safety is presented. The use of standard precision measuring tools including micrometers, dial calipers, vernier scales, etc. is presented.
5. Basic machine setup practices and common cutting tool materials are introduced. Machining operations: turning, milling, grinding, drilling, boring, reaming, and tapping are covered.
6. Define the process of deformation in extrusion, rolling and extrusion.
7. Classify and identify various jigs and fixtures.
8. To inform the students about the various alternative manufacturing processes available. • To develop an altitude to look for the unconventional manufacturing process to machine • To make them to understand and appreciate the latest manufacturing process for micro fabrication and devices.

#	Contents	h
UNIT-1	**FINISHING AND SUPERFINISHING PROCESS -BROACHING PROCESS**	06
	Principle of broaching.Details of a broach.Types of broaching machines-constructional details.Applications.Advantages and Limitations. Finishing and other Processes Lapping and Honing operations – Principles, arrangement of set up and application. Super finishing process, polishing, buffing and application	
UNIT-2	**NON-TRADITIONAL MACHINING PROCESSES**	07
	Need for nontraditional machining, Principle, equipment & operation of Laser Beam, Plasma Arc Machining, Electro Chemical Machining, Ultrasonic Machining, Abrasive Jet Machining, Water Jet Machining, Electron Beam Machining, Electron Discharge Machining and Plasma Arc Machining.	
UNIT-3	**WELDING PROCESS**	10
	Definition, Principles, Classification, Application, Advantages & limitations of welding. Arc Welding: Principle, Metal Arc welding (MAW), Flux Shielded Metal Arc Welding (FSMAW), Inert Gas Welding (TIG & MIG). **RESISTANCE WELDING:** Principles, Friction stir welding process, Laser beam welding, Ultrasonic welding. **PRINCIPLES OF SOLDERING & BRAZING:** Parameters involved & Mechanism. Different Types of Soldering & Brazing Methods.	
UNIT-4	**METAL FORMING**	10
	Forming methods, dies & punches, progressive die, compound die, combination die. Rubber forming, Open back inclinable press (OBI press), piercing, blanking, bending, deep drawing, Types of extrusion processes, extrusion equipment, Extrusion dies, Extrusion of seamless tubes. Extrusion variables, simple problems, piercing, blanking, bending, deep drawing, LDR in drawing, Classification of Rolling processes. Types of rolling mills, expression for Rolling load. Roll separating force, Rolling variables, simple problems.	
UNIT-5	**JIGS AND FIXTURES**	06
	Definition of jig and fixture, Different types of jigs and fixtures;Lathe, Milling, Boring, Shaping, Broaching, Grinding, Assembly and welding fixtures.principles and methods of clamp location, types of clamping and locating elements, calculation of clamping force	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Identify the different finishing processes for a particular operation.
2. Bring out advantages, disadvantages and limitations of different finishing operations.
3. Understand about difference between conventional and non-conventional machining process.
4. Knowledge about principle, working, machining parameters of USM, AJM, ECM, EDM, LBM, EBM and PAM.
5. Understand mechanism of different metal joining processes and its advantages, disadvantages and limitations.
6. Demonstrate the effect of temperature, strain rate in metal working and basic knowledge of press and dies.
7. Calculate different process parameters for rolling, extrusion and drawing
8. To differentiate between jigs and fixtures, its types, classification and methods of clamping.

TEXT BOOKS:

1. **"Manufacturing Process-I",** Dr. K. Radhakrishna, Sapna Book House, 5th Revised Edition 2009.
2. **"Manufacturing & Technology:** Foundry Forming and Welding", P.N. Rao 2nd Ed., Tata McGraw Hill, 2003.
3. **Manufacturing Science,** AmitabhaGhosh and Mallik, affiliated East West Press, 2005.
1. **Manufacturing Process – III,** Dr. K.Radhakrishna, SapnaBook House, 2009.

REFERENCE BOOKS:

1. **"Manufacturing Technology",** SeropeKalpakjain, Steuen.R. Sechmid, Pearson Education Asia, 5th **Ed. 2006.**
2. **"Process and Materials of Manufacturing**", Roy A Lindberg, 4th Ed. Pearson Edu. 2006.

3. **"Principles of Metal Casting",** Rosenthal, Tata McGraw Hill Publications.
4. **Mechanical Metallurgy –** Dieter, Tata McGraw Hill, 2001.

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven Full Questions to be set and Five full Questions to be answered.
2. Unit-1, Unit-2 and Unit-5 are compulsory, with one question from each Unit and from
   Unit-3 and Unit-4: Two questions to be set with choice

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1
7	0	0	2	1	3	1	2	0	2	2	2	2
8	0	0	0	2	2	1	2	1	2	1	2	2

Strong-3, Medium-2, Weak-1

COURSE TITLE : POWER PLANT ENGINEERING (CORE ELECTIVE)		
Sub Code: ME553	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/week : 03
Exam Duration:3hours		Exam Marks : 100
Pre-requisites	Basic Thermodynamics, Fluid Mechanics, Turbo Machines	

COURSE OBJECTIVES:

1. To familiarize with different conventional and non-conventional energy sources.
2. To demonstrate layout and components of Steam power plants, Diesel engine power plants, Hydroelectric power plants, Nuclear power plants
3. To implement principles of power generation through solar energy, Wind energy Ocean, Tidal energy & Fuel cells.
4. To apply basic calculations to understand design principles of conventional energy conversion.
5. To demonstrate competence in understanding performance of energy conversion devices through experiments.

#	Contents	h
UNIT-1	**THERMAL POWER PLANTS**	**07**
	Introduction: Energy sources for generation of electric power, energy policy of India, present status and future trends, major power plants in India. Thermal Power Plants: Selection of site, general layout of the plant, major components- Boilers, Economizers, Super-heaters, Air pre-heaters, fuels, fuel and ash handling equipment, High pressure Boilers, steam turbines, station heat balance and plant efficiency	
UNIT-2	**DIESEL ENGINE POWER PLANT**	**06**
	Introduction; Applications of Diesel Engines in power field, Advantages and disadvantages diesel engine power plant, Types, General layout, Combustion in a CI engine, Performance characteristics, Supercharging, Layout of diesel engine power plant, Numericals.	
UNIT-3	**HYDROELECTRIC POWER PLANTS**	**06**
	Introduction; Classification of hydro-plants, selection of site, rain fall and run off, calculation of storage capacity, plant layout, estimation of power available, selection of hydraulic turbines and their governing, general layout of hydro power plant	
UNIT-4	**NUCLEAR POWER PLANT**	**10**
	Nuclear Power Plants: Introduction, Atomic structure and radio-activities nuclear reactions, binding energy, Nuclear Reactors, Types of reactors, Pressurized water reactors, boiling heater reactors, Heavy water-cooled and moderated (CANDU) reactor, Gas-cooled reactors, Liquid metal cooled reactors, Indian Nuclear power installations, comparison between Nuclear and Thermal plants, Numericals	
UNIT-5	**NON CONVENTIONAL POWER GENERATION**	**10**
	Introduction, Direct energy conversion, MHD, Thermiconic and Thermoelectric power generation, Fuel cells, Geothermal energy, Hydrogen energy systems, Numericals	

TEXT BOOKS

1. **Power Plant Engineering**, P. K. Nag, Tata McGraw Hill , 4th Edition, 2014.
2. **A Text Book of Power Plant Engineering,** R. K. Rajput, Laxmi publication, New Delhi, 4th Edition, 2007.

REFERENCE BOOKS

1. **Power Plant Engineering,** G.R. Nagpal and S.C. Sharma, Khanna Publishers, 16th Edition, 2012.

SYLLABUS COVERAGE FOR CIE

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)
CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit 1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES: On completion of the course, student should be able to;

After completion of the course, students will be able to:

1. Recognize different conventional and non-conventional energy sources.
2. Describe the layout and components of Steam power plants, Diesel engine power plants, Hydroelectric power plants, Nuclear power plants
3. Explain principles of power generation through Solar energy, Wind energy, Ocean, Tidal energy and Fuel cells.
4. Apply basic calculations to understand design principles of conventional and non-conventional energy conversion.
5. Compare advantages & limitations of conventional and non-conventional energy sources.
6. Demonstrate competence in understanding performance of energy conversion devices through experiments.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : HEAT TRANSFER LABORATORY		
Sub Code: MEL56	No of Credits : L-T-P-SS 00:00:02:00 =01	No. of lecture hours/week : 02
Exam Duration:3hours		Exam Marks : 50
Pre-requisites	Basic Thermodynamics, Fluid Mechanics, Heat Transfer	

COURSE OBJECTIVES:

1. To understand the basic conduction, convection and radiation heat transfers.
2. To study combined conduction and convection states of heat transfer.
3. To determine emissivity of a grey body and verify Stefan Boltzmann constant.
4. To determine effectiveness of parallel flow and counter flow heat exchangers.
5. To conduct tests on vapor compression refrigeration.

#	Contents	h
UNIT-1	**MINOR EXPERIMENT**	**10**
	1. Composite wall - Determination of overall heat transfer coefficient of a composite wall. 2. Metal rod - Determination of thermal conductivity of a metal rod. 3. Fin – Determination of efficiency and effectiveness of a fin free convection mode. 4. Emissivity - Determination of emissivity of a given grey surface	
UNIT-2	**MAJOR EXPERIMENT**	**16**
	1. Vertical pipe - Determination of heat transfer coefficient in free convection mode. 2. Pipe flow - Determination of heat transfer coefficient in forced convection mode for hot air flowing through a circular pipe. 3. Stefan Boltzmann constant - Verification of Stefan Boltzmann Constant. 4. Fin - Determination of efficiency and effectiveness of a fin in forced convection mode. 5. Shell and Tube heat exchanger - Determination of Log Mean Temperature Difference (LMTD) and Effectiveness in (i) Parallel Flow mode and (ii) Counter Flow mode 6. Vapour Compression Refrigerator (VCR) – Determination of COP.	

REFERENCE BOOKS

1. **Heat and Mass Transfer,** P.K. Nag, 3rd Edition, Tata McGraw-Hill, 2011.
2. **A Course in Heat and Mass Transfer,** Domkundwar, Arora, Domkundwar, DhanpatRai Publications, 2005.
3. **Basic and Applied Thermodynamics,** P.K. Nag, Tata McGraw-Hill Publications, 2nd Edition, 2010.

SCHEME OF EXAMINATION (SEE)

Sl. No.	Particulars	Max. Marks	Break Up of Max. Marks		
			Write Up	Conduction of experiment	Specimen Calculation, Tabulation of Results and Plotting of Graph
1	**Unit-1: Minor Experiment** (Any ONE from the list of experiments)	**15**	05	05	05
2	**Unit-2: Major Experiment** (Any ONE from the list of experiments)	**25**	05	10	10
3	Viva Voce	**10**	—	—	—
	TOTAL MARKS	**50**	**10**	**25**	**15**

COURSE OUTCOMES: On completion of the course, student should be able to;

After completion of the course, students will be able to:

1. Identify the equipment used for illustrating various modes of heat transfer.
2. Explain the various modes of heat transfer and heat transfer devices with examples and illustrations.
3. Demonstrate the working of equipment used in the laboratory.
4. Illustrate the procedure used to conduct the experiment with equipment.
5. Analyse the expressions to determine the heat transfer rate from various modes of heat transfer.
6. Calculate the rate of heat transfer in different equipment and plot the results of various heat transfer systems.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : FUEL TESTING AND INTERNAL COMBUSTIONENGINES LABORATORY		
Sub Code: MEL57	No of Credits : L-T-P-SS 00:00:02:00 =01	No. of lecture hours/week : 02
Exam Duration:3hours		Exam Marks : 50
Pre-requisites	Basic & Applied Thermodynamics, Heat Transfer	

COURSE OBJECTIVES:

1. To conduct tests on oils to determine flash, fire points and viscosity.
2. To determine calorific value of a given fuel.
3. To plot the valve timing diagram of 2-stroke and 4-stroke IC engine.
4. To calculate the area of an irregular shape using planimenter.
5. To conduct performance test on petrol and diesel IC engine and evaluate the power produced and efficiencies.
6. To conduct Morse test on 4-stroke multi cylinder engine to determine the utility of heat input and draw heat balance sheet.

#	Contents	h
UNIT-1	**MINOR EXPERIMENT**	**10**
	1. Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Martin (closed) / Cleaveland (Open Cup) Apparatus. 2. Determination of Calorific value of solid, liquid and gaseous fuels. 3. Determination of Viscosity of lubricating oil using Redwoods, Saybolts and Torsion Viscometers. 4. Valve Timing/port opening diagram of an I.C. engine (4 stroke/ 2 stroke). 5. Use of planimeter.	
UNIT-2	**MAJOR EXPERIMENT**	**16**
	1. Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal efficiencies, SFC, FP, heat balance sheet for ♦ Four stroke Diesel Engine ♦ Four stroke Petrol Engine ♦ Two stroke Petrol Engine ♦ Multi Cylinder Diesel/Petrol Engine, (Morse test)	

REFERENCE BOOKS

1. Basic and Applied Thermodynamics, P.K. Nag, Tata McGraw-Hill Publications, 2nd Edition, 2010.

SCHEME OF EXAMINATION (SEE)

Sl. No.	Particulars	Max. Marks	Break Up of Max. Marks		
			Write Up	Conduction of experiment	Specimen Calculation, Tabulation of Results and Plotting of Graph
1	**Unit-1: Minor Experiment** (Any ONE from the list of experiments)	**15**	05	05	05
2	**Unit-2: Major Experiment** (Any ONE from the list of experiments)	**25**	05	10	10
3	Viva Voce	**10**	—	—	—
	TOTAL MARKS	**50**	**10**	**25**	**15**

COURSE OUTCOMES: On completion of the course, student should be able to;

After completion of the course, students will be able to:

1. Conduct basic tests on lubricating oil like fire, flash, cloud and pour points along with viscosity.
2. Determine calorific values of all types of fuels.
3. Plot internal combustion engine valve timing diagrams.
4. Calculate the area of irregular shapes using planimeter.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

VI Semester (2014-15)

COURSE TITLE : DESIGN OF MACHINE ELEMENTS – II		
Sub Code: ME61	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/week : 04
Exam Duration:3hours		Exam Marks : 100

COURSE OBJECTIVES:

This course "Design of Machine Elements -II" After clearly understand the design-I – COURSE further he has to learn various other machine components with the following objectives in mind:

1. The student shall gain appreciation and understanding straight and curved beams and general applications of curved beams such as machine frame, punching machine and crane hook, bending and resultant stress occurs at various symmetrical and non-symmetrical crass sections and extended chain links used for curved beams.
2. The student shall be able to understand functions of various spring and its application, types of springs, such as helical, spiral, buffer,conentric and leaf springs and stress induced, deflection, energy stored in the spring, design procedure, selection of suitable material to design and design springs for various suitable applications.
3. The student shall be able to understand meaning of gear drive importance of gear drive, various fields of applications, general classifications, general characteristics, requirements of gear drive, types of tooth profile ,loads, selection of suitable material for gear design stress acting on gears and design procedure to design a different gears for various applications,
4. The student shall be able to understand functions of lubrications, desirable properties, types of lubrications system, selection proper grade of lubrication for particular application, and also to understand functions of bearing, general classification, design procedure to design any bearing, selection of various factors for bearings, determination of life of bearing, selection of proper grade of lubrication suitable and heat generated, heat dissipated etc.

#	Contents	h
UNIT-1	**CURVED BEAMS**	**08**
	Stresses in curved beams of standard cross sections used in crane hook, punching presses & clamps, closed rings and links	
UNIT-2	**SPRINGS**	**12**
	Introduction, classification of springs - stresses in helical coil springs of circular sections, Energy stored in springs, and problems on helical coil springs., Concentric springs, advantages and applications and design of concentric springs under fluctuating loads, Leaf Springs, advantages and applications, classifications: Stresses in leaf springs. Equalized stresses in springs.	
UNIT-3	**SPUR& HELICAL GEARS**	**12**
	SPUR GEARS: Introduction ,classification, advantage, dis-advantages and applications, terminology of spur gears, material selection for spur gear design, stresses in gear tooth: Lewis equation and form factor, Design for strength, Dynamic load and wear load., problems on spur gear	**10** **10**

	HELICAL GEARS: Bevel Gears: Introduction ,classification, advantage, dis-advantages and applications, terminology of helical gears, formative number of teeth, material selection for helical gear design, stresses in gear tooth: Lewis equation and form factor, Design for strength, Dynamic load and wear load., problems on helical gear.	
UNIT-4	**BEVEL AND WORM GEARS**	
	BEVEL GEARS: Introduction, classification, advantage, applications, terminology of bevel gears, formative number of teeth, material selection for bevel gear design, stresses in gear tooth: Lewis equation and form factor, Design for strength, Dynamic load and wear load., problems on bevel gear. **WORM GEARS**: Introduction, classification, advantage, applications, terminology of bevel gears, formative number of teeth, material selection for worm gear design, stresses in gear tooth: Lewis equation, Design for strength, Dynamic load and wear loads and efficiency of worm gear drives and problems on worm gears	
UNIT-5	**LUBRICATION& BEARINGS**	
	LUBRICATION Lubricants and their properties, Classification of bearings, Mechanisms of Lubrication bearing modulus, coefficient of friction, minimum oil film thickness, Heat generated, Heat dissipated. **BEARINGS:** Classification, Bearing Materials, Examples of journal bearing and thrust bearings, selection of ball bearing and journal bearing.	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Define basic concepts of vibration of bodies having one, two and multi degree freedom

   Develop basic mathematical models and Estimate natural frequency of mechanical element/system for undamped and damped mechanical SDOF systems.
2. Discuss equations of motion Analyze vibratory response of mechanical element/system for free un damped and damped and forced vibration respons and estimate the parameters of vibration isolation systems for industrial environment.
3. Ability to find vibration parameters numerically by 2-degree and multi degree freedom by various numerical techniques
4. Explore modern vibration measuring instruments. Condition monitoring of working machineries

TEXT BOOKS

1. **Mechanical Engineering Design**, Joseph E Shigley and Charles R. Mischke. McGraw Hill International edition, 6th Edition 2003.
2. **Design of Machine Elements**, V. B Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2007.

REFERENCE BOOKS

1. Machine Design, Robert L. Norton, Pearson Education Asia, 2001.
2. Design of Machine Elements, M. F. Spotts, T. E. Shoup, L. E. Hornberger, S. R. Jayram and C. V. Venkatesh, Pearson Education, 2006.
3. Machine Design, Hall, Holowenko, Laughlin (Schaum's Outlines series) Adapted by S.K. Somani, Tata McGraw Hill Publishing Company Ltd., New Delhi, Special Indian Edition, 2008.
4. Machine Design, A CAD Approach: Andrew D DIMAROGONAS, John Wiley Sons, Inc, 2001.

DESIGN DATA HANDBOOK

1. **Design Data Hand Book** , K. Lingaiah, McGraw Hill, 2^{nd} Edition.
2. **Data Hand Book,** K. Mahadevan and Balaveera Reddy, CBS Publication
3. **Design Data Hand Book,** H.G. Patil, ShriShashiPrakashan, Belgaum.

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven Full Questions to be set and Five full Questions to be answered.
2. Unit-1, Unit-4 and Unit-5 are compulsory, with one question from each Unit.
3. Unit-2 and Unit-3: Two questions to be set with choice.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	2	2	3	0	3	3	1	3	2
CO2	3	3	3	2	1	3	3	0	3	2	3	2
CO3	3	3	2	3	3	0	3	0	3	2	3	2
CO4	3	3	1	3	3	3	2	1	2	3	2	3

- **High-3**
- **Medium-2**
- **Low-1**

COURSE TITLE : FINITE ELEMENT METHODS		
Sub Code: ME62	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/week : 04
Exam Duration:3hours		Exam Marks : 100

COURSE OBJECTIVES:

1. To impart structures analysis for stress, strain & dynamic loading knowledge
2. To enable formulation of the design problems into FEA.
3. To comprehend the basic concepts and enhance capabilities for solving complex problems.
4. To introduce the concepts of elastic and static analysis problems.

#	Contents	h
UNIT-1	**INTRODUCTION**	**08**
	Equilibrium equations in elasticity subjected to body force, traction forces, and stress-strain relations for plane stress and plane strains. General description of Finite Element Method, Application and limitations. Types of elements based on geometry. Node numbering, Half band width. **BASIC PROCEDURE**: Euler - Langrange equation for bar, beam (cantilever / simply supported fixed) Principle of virtual work, principle of minimum potential energy, Raleigh's Ritz method. Direct approach for stiffness matrix formulation of bar element.Galerkin's method.	
UNIT-2	**INTERPOLATION MODELS**	**12**
	Interpolation polynomials- Linear, quadratic and cubic.Simplex complex and multiplex elements.2D PASCAL's triangle. CST elements-Shape functions and Nodal load vector, Strain displacement matrix and Jacobian for triangular and rectangular element. **SOLUTION OF 1-DIMENSIONAL BARS:** Solutions of bars and stepped bars for displacements, reactions and stresses by using penalty approach and elimination approach. Guass-elimination technique.	
UNIT-3	**HIGHER ORDER ELEMENTS**	**10**
	Lagrange's interpolation, Higher order one dimensional elements-Quadratic and cubic element and their shape functions. Shape function of 2-D quadrilateral element-linear, quadric element Iso-parametric, Sub parametric and Super parametric elements. Numerical integration : 1, 2 and 3 gauge point for 1D and 2D cases.	
UNIT-4	**TRUSSES**	**10**
	Stiffness matrix of Truss element.Numerical problems	
UNIT-5	**BEAMS**	**12**
	Hermite shape functions for beam element, Derivation of stiffness matrix. Numerical problems of beams carrying concentrated, UDL and linearly varying loads	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. To teach the students about the concepts of FEM and FEA.
2. Develop the knowledge to analyse structures under static and dynamic conditions.
3. Identify the numerical techniques for solving engineering problems using FEM.
4. Identify types of elements such as higher order, beams , trusses for different applications.

TEXT BOOKS:

1. **Finite Elements in Engineering**, T.R.Chandrupatla, A.D Belegunde, 3rd Ed PHI.
2. **Finite Element Method in Engineering**, S.S. Rao, 4th Edition, Elsevier, 2006.

REFERENCE BOOKS:

1. **"Finite Element Methods for Engineers"** U.S. Dixit, Cengage Learning, 2009.
2. **Concepts and applications of Finite Element Analysis**, R.D. Cook D.S Maltus, M.E Plesha, R.J.Witt, Wiley 4th Ed, 2009
3. **Finite Element Methods**, Daryl. L. Logon, Thomson Learning 3rd edition, 2001.
4. **Finite Element Method**, J.N. Reddy, McGraw -Hill International Edition.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven Full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-3 and Unit-4 are compulsory, with one question from each Unit.
4. Unit-2 and Unit-5: Two questions to be set with choice.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : MECHANICAL VIBRATIONS		
Sub Code: ME63	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/week : 04
Exam Duration:3hours		Exam Marks : 100

COURSE OBJECTIVES:

1. To observe, analyze and understand the concept of vibrations in mechanical systems , various technique to solve single degree freedom and single dof without damping with damping, 2-degree, forced vibration and, determine Estimate natural frequency of mechanical system multi degree freedom system using various numerical techinques.
2. To comprehend the fundamentals of vibration theory types of vibrations and
3. To recognize how to apply theory of vibration to engineering problems.
4. To be able to mathematically formulate real-world vibration problems in engineering

#	Contents	h
UNIT-1	**INTRODUCTION**	08
	Types of vibration, Definitions, Simple Harmonic Motion (S.H.M.), Work done by harmonic force, Principle of super position applied to SHM, Beats. **UNDAMPED FREE VIBRATIONS** Classic spring mass systems of single degree of freedom, Different methods of determination of natural frequencies of simple systems, Springs in series and parallel, Torsional and transverse vibrations, Effect of mass of spring	
UNIT-2	**DAMPED FREE VIBRATIONS**	12
	Types of damping, Analysis with viscous damping - Derivations for overdamped, critically damped and under damped systems, Logarithmic decrement and numericals. Whirling of shafts with and without damping, speed discussion below and above critical speeds,Numericals	
UNIT-3	**FORCED VIBRATIONS**	14
	Introduction, Analysis of forced vibration with constant harmonic excitation - magnification factor, rotating and reciprocating unbalances, support excitation for relative and absolute amplitudes, force and motion transmissibility. **VIBRATION MEASURING INSTRUMENTS:** Introduction to Vibrometers, Accelerometer, Frequency measuring instruments	
UNIT-4	**SYSTEMS WITH TWO DEGREES OF FREEDOM**	08
	Principle modes and normal modes of vibrations, natural frequencies of systems (without damping) – Simple spring mass systems, torsional systems, combined rectilinear and angular systems, geared semi-defined systems, semi-definite systems and numericals. Dynamic vibration absorber.	
UNIT-5	**NUMERICAL METHODS FOR MULTI DEGREE FREEDOM OF SYSTEMS**	10
	Introduction, Maxwell's reciprocal theorem, Influence coefficients, Rayleigh's method, Dunkerley'smethod.Problems on Stodola method and Holzer's methods only.Orthogonality of principal modes; Introduction to Modal analysis and Condition Monitoring	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Define basic concepts of vibration of bodies having one, two and multi degree freedom Develop basic mathematical models and Estimate natural frequency of mechanical element/system for undamped and damped mechanical SDOF systems.
2. Discuss equations of motion Analyze vibratory response of mechanical element/ system for free un damped and damped and forced vibration respons and estimate the parameters of vibration isolation systems for industrial environment.
3. Ability to find vibration parameters numerically by 2-degree and multi degree freedom by various numerical techniques
4. Explore modern vibration measuring instruments. Condition monitoring of working machineries

TEXT BOOKS:

1. **Mechanical Vibrations,** G. K.Grover, Nem Chand and Bros, 7th edition, 2003.
2. **Mechanical Vibrations,** S. S. Rao, Pearson Education Inc, 4th edition, 2003.
3. **Mechanical Vibrations,** V. P. Singh, DhanpatRai& Company, 3rd edition, 2006.

REFERENCE BOOKS:

1. **Theory of Vibration with Applications,** W. T. Thomson, M. D. Dahleh and C. Padmanabhan, Pearson Education Inc, 5th edition, 2008.
2. **Mechanical Vibrations:** S. Graham Kelly, Schaum's outline Series, Tata McGraw Hill, Special Indian Edition, 2007.
3. **Theory and Practice of Mechanical Vibrations:** J. S. Rao& K. Gupta, New Age International Publications, New Delhi, 2001.
4. **Vibration Fundamentals**, R. Keith Mobley, Newness, 1999.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven Full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-4 and Unit-5 are compulsory, with one question from each Unit.
4. Unit-2 and Unit-3: Two questions to be set with choice.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	2	2	3	3	2	3	3	1	2
2	2	3	3	2	2	1	3	2	3	3	3	2
3	3	3	3	2	3	2	3	1	3	2	3	2
4	3	3	2	2	3	2	3	1	2	2	3	3

High-3 Medium-2 Low-1

COURSE TITLE : OPERATIONS RESEARCH		
Sub Code: ME64	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/week : 04
Exam Duration:3hours		Exam Marks : 100

SUBJECT OBJECTIVES:

1. Explain the historical development of OR and its areas of applications.
2. Formulate the mathematical model of managerial problems like product mix etc.
3. Solve the problems where the variables are linear in nature by graphical method and simplex method.
4. Formulate and solve balanced and unbalanced Transportation problems.
5. Formulate and solve assignment problem.
6. Draw the project network diagram and schedule the project.
7. Analyze queuing system and find its parameters.
8. Formulate two person-zero sum game.
9. Find the best strategy for the given game by graphical and dominance methods

#	Contents	h
UNIT-1	**INTRODUCTION**	**08**
	Evolution of OR, definition of OR, scope of OR, application areas of OR, steps (phases) in OR study, characteristics and limitations of OR, models used in OR, linear programming (LP) problem-formulation and solution by graphical method. **SOLUTION OF LINEAR PROGRAMMING PROBLEMS**: The simplex method-canonical and standard form of an LP problem, slack, surplus and artificial variables.	
UNIT-2	**TRANSPORTATION PROBLEM**	**14**
	Formulation of transportation problem, types, initial basic feasible solution using different methods, optimal solution by MODI method, degeneracy in transportation problems, application of transportation problem concept for maximization cases. Assignment Problem-formulation, types, application to maximization cases and travelling salesman problem	
UNIT-3	**PERT-CPM TECHNIQUES**	**14**
	Introduction, network construction - rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects	
UNIT-4	**GAME THEORY**	**08**
	Formulation of games, types, solution of games with saddle point, graphical method of solving mixed strategy games, dominance rule for solving mixed strategy games. **SEQUENCING:** Basic assumptions, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines.Sequencing 2 jobs on 'm' machines using graphical method	
UNIT-5	**REPLACEMENT**	**08**
	Replacement items deteriorating with time, when money value remains same Replacement of items which fail suddenly; Individual replacement policy Group replacement policy **QUEUING THEORY:** Queuing systems and their characteristics, Pure-birth and Pure-death models (only equations), empirical queuing models – M/M/1 and M/M/C models and their steady state performance analysis.	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Define models for linear programming
2. Convert the linear variable problems to a mathematical model and depict by graphical method.
3. Apply artificial variable technique to solve a linear programming model.
4. Compute the minimum cost of transportation by Modi's method and Hungarian method.
5. Design a project network diagram and schedule the project activities and duration.
6. Illustrate the strategies of different players in a game and find the best strategy by graphical and dominance method

TEXT BOOKS

1. **Operations Research,** P K Gupta and D S Hira, Chand Publications, New Delhi - 2007
2. **Operations Research,** Taha H A, Pearson Education

REFERENCE BOOKS

1. **Operations Research,** A P Verma, S K Kataria&Sons, 2008
2. **Operations Research,** Paneerselvan, PHI
3. **Operations Research,** A M Natarajan, P Balasubramani, Pearson Education, 2005
4. **Introduction to Operations Research,** Hiller and Liberman, McGraw Hill.

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven Full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-4 and Unit-5 are compulsory, with one question from each Unit.
4. Unit-2 and Unit-3: Two questions to be set with choice.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : THEORY OF ELASTICITY (CORE ELECTIVE)		
Sub Code: ME651	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/week : 03
Exam Duration:3hours		Exam Marks : 100

COURSE OBJECTIVES:

1. To study the basic concept of stresses, stress distribution, elastic constants when the material is subjected to loading within the elastic limits
2. Study the stress distribution in plane, polar and cylindrical coordinate systems
3. Analyze the material or component subjected to torsion of circular and non-circular shafts (elliptical, triangular bars)

#	Contents	h
UNIT-1	**DEFINITION AND NOTATION**	10
	Stress, Stress at a Point, Equilibrium Equations, Principal Stresses, Mohr's Diagram, Maximum Shear Stress, Boundary Conditions. **STRAIN AT A POINT:** Compatibility Equations, Principal Strains, Generalised Hooke's law, Methods of Solution of Elasticity Problems – Plane Stress-Plane Strain Problems. **UNIQUENESS THEOREM:** Principle of super position, reciprocal theorem, saint venant principle. And make it with internal choice	
UNIT-2	**TWO DIMENSIONAL PROBLEMS**	07
	Cartesian co-ordinates – Airy's stress functions – Investigation of Airy's Stress function for simple beam problems – Bending of a narrow cantilever beam of rectangular cross section under edge load – method of Fourier analysis – pin ended beam under uniform pressure	
UNIT-3	**STRESSES IN AN INFINITE PLATE**	10
	(with a circular hole) subjected to uniaxial and biaxial loads, stress concentration, stresses in rotating discs and cylinders. **GENERAL EQUATIONS IN CYLINDRICAL CO-ORDINATES:** Thick cylinder under uniform internal and / or external pressure, shrink and force fit, stress concentration	
UNIT-4	**THERMAL STRESSES**	07
	Thermo elastic stress strain relationship, Equations of equilibrium Thermal stresses in thin circular discs and in long circular cylinder, sphere. **TORSION OF CIRCULAR, ELLIPTICAL AND TRIANGULAR BARS:** membrane analogy, torsion of thin open sections and thin tubes	
UNIT-5	**UNIQUENESS THEOREM**	05
	Principle of super position, reciprocal theorem, saint venant principle	

COURSE OUTCOMES:

1. Make the students to understand the concept of elastic and plastic behavior of the material

2. Analyze the stress and strain tensors at a point in a member subjected to loading (point/distributed)
3. Applying the concept of compatibility and equilibrium conditions to analyze the stress and strain tensors
4. Study the thermo-elastic properties of the material at elevated temperatures
5. Analyzing the stress concentration factor of a structural component subjected to different types of load
6. Analyzing the different types of uniqueness theorems

TEXT BOOKS:

1. **Advanced Mechanics of solids**, L. S. Srinath, Tata Mc. Graw Hill, 2003
2. **Theory of Elasticity,** S. P. Timoshenko and J. N Gordier, Mc.Graw Hill International, 3rd edition, 1972

REFERENCES BOOKS:

1. **Theory of Elasticity,** Dr. Sadhu Singh, Khanna Publications, 1988
2. **Elasticity, Theory, Applications &Numericals,** Martin H Sadd, Elsevier. 2005
3. **Applied Elasticity,** Seetharamu&Govindaraju, Interline Publishing
4. **Applied Elasticity,** C.T. WANG Sc. D. Mc. Graw Hill Book Co.1953.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven Full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-4 and Unit-5 are compulsory, with one question from each Unit.
4. Unit-1 and Unit-3: Two questions to be set with choice.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	2	2	0	1	0	1	0	3	1	3	0
2	2	3	2	2	1	0	1	0	3	1	3	0
3	3	3	2	1	3	0	1	0	3	2	3	2
4	0	1	2	1	3	1	2	0	2	2	2	2
5	0	0	0	2	2	1	2	1	2	1	2	2
6	0	3	0	1	1	0	0	0	1	2	2	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : COMPOSITE MATERIALS AND MANUFACTURING(CORE ELECTIVE)		
Sub Code: ME652	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/week : 03
Exam Duration:3hours		Exam Marks : 100

COURSE OBJECTIVES:

1. Understand capabilities and limitations of existing materials and processes.
2. Define property enhancement mechanisms.
3. To understand the fundamentals of composite material strength and its mechanical behavior
4. Understanding the analysis of fiber reinforced Laminate design for different combinations of plies with different orientations of the fiber.
5. Determine opportunities for improvement.
6. Select materials and processes to best suit specific applications.
7. To develop knowledge on processing, interfacial properties and application of composites
8. An ability to predict the elastic properties of both long and short fiber composites based on the constituent properties.

#	Contents	h
UNIT-1	**INTRODUCTION**	07
	General introduction to composites; historical background; concept of matrix and reinforcement and particulates. **MATRIX AND REINFORCEMENT** Types of matrix and reinforcement, volume fraction and weight fraction Fiber architecture fiber packing arrangements, whiskers	
UNIT-2	**FABRICATION METHODS OF POLYMER COMPOSITES**	06
	Liquid resin impregnated routes, pressurized consolidation of resin pre-pegs, consolidation of resin molding compounds, injection molding of thermoplastics, hot press molding of thermoplastics.	
UNIT-3	**FABRICATION OF CERAMIC COMPOSITES**	10
	Powder based routes, reactive processing, layered ceramic composites, carbon/carbon composites, **FABRICATION ROUTES OF METAL MATRIX COMPOSITES** Squeeze infiltration, stir casting, spray deposition, powder blending and consolidation, diffusion bonding of foils, PVD	
UNIT-4	**TESTING AND CHARACTERIZATION**	10
	Different tests like internal stress measurement by diffraction, metallographic preparation etc with special emphasis to metal matrix composites **SECONDARY PROCESSING AND APPLICATION OF COMPOSITES** Secondary processing like machining, joining, extrusion of composites; Application and case studies	
UNIT-5	**SMART MATERIALS**	06
	Introduction and properties of piezoelectric materials, shape memory alloys, ER and MR fluids, electrostrictive and magntostrictive materials as smart materials, applications	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. To study matrix material, particulates and fibres of polymer matrix composites, MMC and ceramic matrix composites.
2. An ability to identify the properties of fiber and matrix materials used in commercial composites, as well as some common manufacturing techniques.
3. An understanding of how composites are used in the design of structures and Understand composite material and processing requirements for optimizing composite performance.
4. An ability to understand and select suitable processes for fiber reinforced, metal matrix composites and ceramic composites.
5. An ability to test and characterize the composites with more emphasis metal matrix composites.
6. An ability to process composites through secondary processing techiniques such as machining, joining and extrusion.

TEXT BOOKS:

1. S.C.Sharma Composite materials Narosa Publishers

REFERENCE BOOKS:

1. R.K.Everret& R.J. Arsenault Metal matrix composite Academic press
2. T. W. Clyne& P. J. Withers Introduction to metal Matrix Composite Cambridge press

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-2 and Unit-5 are compulsory, with one full question from each Unit.
4. Unit-3 and Unit-4: Two full questions to be set with choice

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : HEATING, VENTILATION AND AIR CONDITIONING (CORE ELECTIVE)		
Sub Code: ME653	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/week : 03
Exam Duration:3hours		Exam Marks : 100
Pre-requisites	Basic & Applied Thermodynamics, Heat Transfer, Refrigeration	

COURSE OBJECTIVES:

1. To understand concept of Psychrometry and explain various air conditioning processes.
2. To explain design conditions for human comfort and critical loading conditions.
3. To calculate the various cooling loads to select the air conditioning apparatus..
4. To understand the various heat sources for optimal design of dehumidifying coils and another air conditioning apparatus.
5. To design the air ducts for proper ventilation and distribution of clean air through the airc conditioned space.

#	Contents	h
UNIT-1	**PSYCHROMETRY**	**06**
	Introduction to air conditioning:Brief history, Working substance, Psychrometric properties, Wet bulb temperature, Adiabatic saturation, Psychrometric chart, Application of I law to Psychrometric process; Psychrometry of air conditioning processes – Mixing process, Basic processes, Psychrometric processes in air conditioning equipment, Simple air conditioning, Summer and winter air conditioning system, Apparatus Dew Point, Numericals	
UNIT-2	**DESIGN CONDITIONS**	**06**
	Introduction; Choice of inside design conditions, Comfort, Outside design conditions, Choice of supply design conditions, Critical loading conditions, Clean spaces; Heat transfer through building structures, Overall heat-transmission coefficient, Empirical methods to evaluate heat transfer through walls and roofs, Natural ventilation through infiltration, Passive heating and cooling of buildings, Water vapour transfer through structures, Numericals.	
UNIT-3	**LOAD CALCULATIONS**	**07**
	Introduction; Preliminary considerations, Internal heat gains, System heat gains, Break-up of ventilation load and effective sensible heat factor, Cooling load and heating load estimate, Psychrometric calculations for cooling, Selection of air conditioning apparatus for cooling and dehumidification, evaporative cooling, Building requirements and energy conservation in air conditioned buildings, Numericals	
UNIT-4	**DESIGN OF AIR CONDITIONING APPARATUS**	**10**
	Introduction: Heating systems – warm air systems – hot water systems – steam heating systems – panel and central heating systems, Heat pump circuit, Heat sources for heat pump. Air conditioning apparatus, Heat and moisture transfer, Design of cooling and dehumidifying coils, Optimal design, Design of air washers and cooling towers, Numericals	

UNIT-5	**TRANSMISSION AND DISTRIBUTION OF AIR**	**10**
	Introduction: Room air distribution, Total, static and velocity pressures, Friction and dynamic loss in ducts, Air flow through simple duct system, Air-duct design, Processing, transmission and distribution of air in clean rooms, Air locks, Air curtains and Air showers, Numericals	

TEXT BOOKS:

1. **Refrigeration and Air Conditioning,** C.P. Arora, McGraw-Hill Education (India) Pvt. Limited, 3rd Edition, 2009.
2. **Refrigeration and Air Conditioning,** Manohar Prasad, New Age International (P) Limited Publishers, 3rd Edition, 2015.

REFERENCE BOOKS

1. **Hand Book Air Conditioning and Refrigeration,** Shan K Wang, 2nd Edition, McGraw-Hill Publications, 2000.
2. **Refrigeration and Air Conditioning,** W.F. Stoecker, and J.W. Jones, 2nd Edition, Tata McGraw-Hill Publications, 1982.
3. **ASHRAE Handbook- Fundamentals,** American Society of Heating, Refrigerating and Air-Conditioning, Engineers Inc., Atlanta, USA, 1997.

DATA HAND BOOKS AND CHARTS

1. **Refrigeration Tables and Charts: SI Units,** C.P. Kothandaraman**,** 4th Edition, New Age International Publishers, 2015.

SYLLABUS COVERAGE FOR CIE

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)
CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Describe the properties of moist air, design conditions and load calculations for heating, ventilation and air conditioning purposes.
2. Distinguish the various air conditioning system and heat gains, used in the design conditions.
3. Solve problems related to application of various air conditioning apparatus and transmission and distribution of air.
4. Analyse the design conditions and load calculations for the given air conditioning apparatus.

5. Derive mathematical expressions and equations to determine the various design and load parameters in designing the air conditioning equipment.
6. Calculate the Psychrometric properties, critical loading conditions, system heat gains, air flow rates in various air conditioning equipment.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
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3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : COMPUTER INTEGRATED MANUFACTURINGLABORATORY		
Sub Code: MEL66	No of Credits : L-T-P-SS 00:00:02:00 =01	No. of lecture hours/week : 02
Exam Duration:3hours		Exam Marks : 50

COURSE OBJECTIVES:

1. Computer based numerically controlled machine tools are increasingly finding place in industries.
2. Further integration of the computer Aided Design Drafting (CADD), Which has been in use in the industry for some years now, with (CAM) Operations has led to efficient product design & prototyping and shorter production runs.
3. The need to absorb, CAD/ CAM technology for its effectives has, therefore, become imperative.
4. This course is being introduced as Practical course of BE programme in mechanical engineering.
5. The course aims at developing appreciation of the use of CAD/CAM environment, its Components, their functions, and methods of using the existing CAD/ CAM software, in general, with a view to improve efficiency in drafting and designing

#	Contents	h
UNIT-1	**PART PROGRAMMING**	**20**
	➢ CNC part programming using CAM packages. ➢ Simulation of Turning, Drilling, Milling operations. ➢ Three typical simulations to be carried out using simulation packages like Master- CAM, or any equivalent software	
UNIT-2	**ONLY FOR DEMO/VIVA VOCE)**	**08**
	➢ FMS (Flexible Manufacturing System): Programming of Automatic storage and Retrieval system (ASRS) and linear shuttle conveyor Interfacing CNC lathe, milling with loading unloading arm and ASRS to be carried out on simple components. ➢ Robot programming: Using Teach Pendent & Offline programming to perform pick and place, stacking of objects, 2 programs	
UNIT-3	**(ONLY FOR DEMO/VIVA VOCE)**	**08**
	Pneumatics and Hydraulics, Electro-Pneumatics: Three typical experiments on Basics of these topics to be conducted	

REFERENCES TEXT BOOKS :

1. **Advanced Mechanics of solids**, L. S. Srinath, Tata Mc. Graw Hill, 2003
2. **Theory of Elasticity,** S. P. Timoshenko and J. N Gordier, Mc.Graw Hill International, 3rd edition, 1972
3. **Theory of Elasticity,** Dr. Sadhu Singh, Khanna Publications, 1988
4. **Applied Elasticity,** Seetharamu&Govindaraju, Interline Publishing

QUESTION PAPER PATTERN (SEE)

UNIT	1	2
Q. No.	Q1	Q2,

SCHEME OF EXAMINATION (SEE)

Sl. No.	Particulars	Max. Marks	Break Up of Max. Marks		
			Write Up	Conduction of experiment / Modelling prossing	Out Put Results (Various turning and milling operations) and Plotting Time, power, Graph if any and generate NC program if required)
1	**Unit-1: Minor Experiment** (Any ONE from the list of experiments and it is purely individual Experiment) Q1	**15**	05	05	05
2	**Unit-2: Major Experiment** (Any ONE **Experiment** from the list of experiments and it is a Group Experiment) Q2	**25**	05	10	10
3	Viva Voce	**10**	—	—	—
	TOTAL MARKS	**50**	**10**	**25**	**15**

- Two Full Questions to be set.
- Students shall be to be answered two full Questions.
- Each question(Experiments contains different Marks and it is clearly mentioned in the above table)
- Changing of Experiments is not allowed from any unite if changing of experiments allowed 50% marks will be deducted.
- Viva Voce is compulsory

COURSE OUTCOMES: On completion of the course, student should be able to;

1. At the end of the COURSE, he must be in a position to giving the solutions by his depth of the COURSE knowledge to perform any machining operation with maximum accuracy as per the required standard by CNC easily.
2. This will enhance to improve the large production with zero rejection of industries.
3. Thus industrial peoples can able to fulfill the customer requirements.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	2	2	3	3	2	3	3	1	2
CO2	2	3	3	2	2	1	3	2	3	3	3	2
CO3	3	3	3	2	3	2	3	1	3	2	3	2
CO4	3	3	2	2	3	2	3	1	2	2	3	3

- **High-3**
- **Medium-2**
- **Low-1**

COURSE TITLE : DESIGN LABORATORY		
Sub Code: MEL67	No of Credits : L-T-P-SS 00:00:02:00 =01	No. of lecture hours/week : 02
Exam Duration:3hours		Exam Marks : 50

COURSE OBJECTIVES:

1. The main objective of this lab is to expose the student of mechanical engineering to various experimental techniques in order to prepare them for their professional career (Industrial and or R&D). The equipment's / instrumentation proposed are expected to provide the students a lot of insight into various experimental techniques in general and those connected with major mechanical systems in particular.
2. The experiment sequence is arranged in such a way to facilitate to introduce the students to engineering fundamentals, to develop their abilities to design experiments, and to motivate them to learn computer applications for data analysis

#	Contents	h
UNIT-1	**PHOTO-ELASTIC BENCH**	**18**
	1. Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (longitudinal and torsional). 2. Determination of critical speed of a rotating shaft. 3. Determination of Fringe constant of Photoelastic material using (a) Circular disc subjected to diametral compression (b) Pure bending specimen (four point bending). 4. Determination of stress concentration using Photoelasticity for simple components like plate with a hole under tension or bending, circular disk with circular hole under compression, 2D Crane hook	
UNIT-2	**GOVERNORS AND GYROSCOPES**	**18**
	1. Determination of centrifugal force of Porter/ Watt /Hartnel Governor. (Only one or more). 2. Determination of Principal Stresses and strains in a member to combined loading using Strain rosettes. 3. Experiments on Gyroscope.	

QUESTION PAPER PATTERN (SEE)

UNIT	1	2
Q. No.	Q1	Q2,

SCHEME OF EXAMINATION (SEE)

Sl. No.	Particulars	Max. Marks	Break Up of Max. Marks		
			Write Up	Conduction of experiment	Specimen Calculation, Tabulation of Results and Plotting of Graph if any
1	**Unit-1: Minor Experiment** (Any ONE from the list of experiments and it is purely individual Experiment) Q1	**15**	05	05	05
2	**Unit-2: Major Experiment** (Any ONE **Experiment** from the list of experiments and it is a Group Experiment) Q2	**25**	05	10	10
3	Viva Voce	**10**	—	—	—
	TOTAL MARKS	**50**	**10**	**25**	**15**

- ❖ Two Full Questions to be set.
- ❖ Students shall be to be answered two full Questions.
- ❖ Each question(Experiments contains different Marks and it is clearly mentioned in the above table)
- ❖ Changing of Experiments is not allowed from any unite if changing of experiments allowed 50% marks will be deducted.
- ❖ Viva Voce is compulsory

REFERENCES TEXT BOOKS :

1. **Advanced Mechanics of solids**, L. S. Srinath, Tata Mc. Graw Hill, 2003
2. **Theory of Elasticity,** S. P. Timoshenko and J. N Gordier, Mc.Graw Hill International, 3rd edition, 1972
3. **Theory of Elasticity,** Dr. Sadhu Singh, Khanna Publications, 1988
4. **Elasticity, Theory, Applications &Numericals,** Martin H Sadd, Elsevier. 2005
4. **Applied Elasticity,** Seetharamu&Govindaraju, Interline Publishing

COURSE OUTCOMES: On completion of the course, student should be able to;

The major impact of the state of the art machine design lab is the exposure the students get to the modern experimental techniques and instrumentation. The experiments are planned in such a way that by the end of the course, the student is expected to have enough potential to design the experimentation as required at that point of time.

1. The major impact of the state of the art machine design lab is the exposure the students get to the modern experimental techniques and instrumentation.
2. Students will be able to understand the essence of kinetics and dynamics through experiments.
3. Students will be able to visualize the stresses developed in an object through photo elasticity implementation of concept of stress concentration in design.

4. The experiments are planned in such a way that by the end of the course, and the student has potential to design the experimentation as required at that point of time.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	2	2	3	3	2	3	3	1	2
CO2	2	3	3	2	2	1	3	2	3	3	3	2
CO3	3	3	3	2	3	2	3	1	3	2	3	2
CO4	3	3	2	2	3	2	3	1	2	2	3	3

- ❖ **High-3**
- ❖ **Medium-2**
- ❖ **Low-1**

44

COURSE TITLE : MINI-PROJECT WORK		
Sub Code: MEP68	No of Credits : L-T-P-SS 00:00:04:00 =02	No. of lecture hours/week : 04
Exam Duration:3hours		Exam Marks : 50

COURSE OBJECTIVES:

1. To instill an atmosphere in students to find a working situation and discover the workable area
2. To insure a transition from planned laboratory course to planning one independently.

#	Contents	h
UNIT-1	**FABRICATION**	**52**
	Simple fabrication related to mechanical projects on a mini scale	
	OR	
UNIT-2	**MODELING & ANALYSIS**	**52**
	Projects using Modeling and analysis tools project related to realistic problems of mechanical stream	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Literature review on national journal standards and define the problem
2. Design Experiments scientifically / Perform Numerical Analysis / Develop Analytical models to Interpret the Results and Prepare quality document

SCHEME OF VALUATION:

Departments shall constitute a Departmental Project Review Committee(faculty+guide)
Project evaluation shall be done by the departmental committee along with the guide and the marks shall be submitted to exam section.
CIE-1: project evaluation in the middle of the semester for 25 marks.
CIE-2: project evaluation at the end of the semester for 25 marks.
SEE: evaluation by both internal and external examiners for 50 marks by conducting project viva-voce.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

SYLLABUS

2016-17

Aided By Govt. of Karnataka

Department of
Mechanical Engineering
7th and 8th Semester

Dr. AMBEDKAR INSTITUTE OF TECHNOLOGY

(An Autonomous Institution, Affiliated to VTU, Belagavi)

Near JnanaBharathi Campus, BDA Outer Ring Road,

Mallathahalli, Bengaluru – 560056

Dr. AMBEDKAR INSTITUTE OF TECHNOLOGY
BANGALORE - 56
AIDED BY GOVERNMENT OF KARNATAKA
&
AN AUTONOMUS INSTITUTION AFFILIATED TO VTU, BELGAVI,

Vision

- To create Dynamic, Resourceful, Adept and Innovative Technical professionals to meet global challenges.

Mission

- To offer state-of-the-art undergraduate, postgraduate and doctoral programs in the fields of Engineering, Technology And Management
- To generate new knowledge by engaging faculty and students in research, development and innovation.
- To provide strong theoretical foundation to the students, supported by extensive practical training to meet the industry requirements.
- To install moral and ethical values with social and professional commitment.

SCHEME AND SYLLABUS FOR ADMISSION BATCH 2013-14

FOR 2013 BATCH - 7th SEMESTER			**L**	**T**	**P**	**C**
1	HS05**	INTELLECTUAL PROPERTY RIGHTS	2	0	0	2.0
2	IDE	INTER-DEPARTMENT ELECTIVE	4	0	0	4.0
3	ME71	CONTROL ENGINEERING	4	0	0	4.0
4	ME721	THEORY OF PLASTICITY	3	0	0	3.0
	ME722	PRODUCT DESIGN & MANUFACTURING	3	0	0	3.0
	ME723	AUTOMOTIVE ENGINEERING	3	0	0	3.0
5	ME731	FRACTURE MECHANICS	3	0	0	3.0
	ME732	ADVANCED WELDING PROCESSES	3	0	0	3.0
	ME733	ADVANCED HEAT TRANSFER	3	0	0	3.0
6	ME741	ENGINEERING TRIBOLOGY	3	0	0	3.0
	ME742	INDUSTRIAL ROBOTICS	3	0	0	3.0
	ME743	SOLAR ENERGY ENGINEERING	3	0	0	3.0
7	MEL75	CAMA LABORATORY	2	0	0	1.0
8	MEP76	PROJECT WORK PHASE-I	2	0	0	0.0
		SEVENTH SEMESTER TOTAL CREDITS				20.0

FOR 2014 BATCH -8rd SEMESTER			L	T	P	C
1	IDE	INTER-DEPARTMENTAL ELECTIVE	4	0	0	4.0
2	ME81	HYDRAULICS & PNEUMATICS	4	0	0	4.0
3	ME821	ENGINEERING DESIGN	3	0	0	3.0
	ME822	FOUNDRY TECHNOLOGY	3	0	0	3.0
	ME823	BIOMASS ENERGY SYSTEMS	3	0	0	3.0
4	ME831	OPERATIONS RESEARCH	3	0	0	3.0
	ME832	NANO TECHNOLOGY	3	0	0	3.0
	ME833	COMPUTATIONAL FLUID DYNAMICS	3	0	0	3.0\
5	ME841	ENGINEERING SYSTEM DESIGN	3	0	0	3.0
	ME842	COMPOSITE MATERIALS AND MANUFACTURING	3	0	0	3.0
	ME843	INTERNAL COMBUSTION ENGINES	3	0	0	3.0
6	ME851	DESIGN FOR MANUFACTURING & ASSEMBLY	3	0	0	3.0
	ME852	INSPECTION & QUALITY CONTROL	3	0	0	3.0
	ME853	HEAT TRANSFER IN ELECTRONIC EQUIPMENT	3	0	0	3.0
7	MES86	SUBJECT SEMINAR	0	0	4	2.0
8	MEP87	PROJECT WORK PHASE-II	0	0	16	8.0
		EIGHTH SEMESTER TOTAL CREDITS				30.0
		FOURTH YEAR TOTAL CREDITS				50.0
		CUMULATIVE CREDITS				200.0

VII SEMESTER

Sub Title: INTELLECTUAL PROPERTY RIGHTS		
Sub Code: HS04	No of Credits : 02:00:00	No of lecture hours/week :02
Exam Duration:2hours	Exam Marks : 50	

COURSE OBJECTIVES:

1. The main objective of the IPR is to make the students aware of their rights for the protection of their invention done in their project work.
2. To get registration in our country and foreign countries of their invention, designs and thesis or theory written by the students during their project work and for this they must have knowledge of patents, copy right, trademarks, designs and information Technology Act.
3. Further teacher will have to demonstrate with products and ask the student to identify the different types of IPR's.

Unit No	Syllabus contents	No of Hours
1	**INTRODUCTION:** Meaning of property, Origin, Nature, Meaning of Intellectual Property Rights, Provision of IPR under TRIPS and WTO. Kinds of Intellectual property rights—Copy Right, Patent, Trade Mark, Trade Secret and trade dress, Design, Layout Design, Geographical Indication, Plant Varieties and Traditional Knowledge	8
2	**PATENT RIGHTS AND COPY RIGHTS—** Origin, Meaning of Patent, Types, Inventions which are not patentable, Registration Procedure, Rights and Duties of Patentee, Assignment and licence , Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties. **COPY RIGHT—**Origin, Definition &Types of Copy Right, Registration procedure, Assignment & licence, Terms of Copy Right, Infringement, Remedies, Copy rights with special reference to software.	10
3	**TRADE MARKS —** Origin, Meaning & Nature of Trade Marks, Types, Registration of Trade Marks, Infringement & Remedies, Offences relating to Trade Marks, Passing Off, Penalties.	10
4	**DESIGN-** Meaning, Definition, Object, Registration of Design, Cancellation of Registration, International convention of design- types and functions. Semiconductor Integrated circuits and layout design Act-2000.	12
5	**BASIC TENENTS OF INFORMATION TECHNOLOGY ACT-2000-** Cyber crimes, digital signature and E-Commerce.rationale: Objectives, Scope and role of SSI in economic Development, Advantages of SSI, Steps to start an SSI, Government Policy towards SSI; Government support for SSI during Five years plans, Impact of Liberalization, Privatization Globalization on SSI, Effect of WTO/GATT. Ancillary Industry and Tiny Industry (definition only). **SUPPORTING AGENCIES OF GOVERNMENT FOR SSI:** Meaning Nature of support; Objectives, function, Types of Help. **INSTITUTIONAL SUPPORT:** Different Schemes, KIADB, KSSIDC, KSIMC	12

COURSE OUTCOMES:

CO1: The students once they complete their academic projects, they get awareness of acquiring the patent and copyright for their innovative works. They also get the knowledge of plagiarism in their innovations which can be questioned legally.

COs	Mapping with POs
CO1	PO8,PO11,PO12

TEXT BOOKS:

1. Intellectual Property Rights and the Law, Gogia Law Agency, by Dr. G.B. Reddy
2. Law relating to Intellectual Property, Universal Law Publishing Co, by Dr. B.L.Wadehra
3. IPR by P. Narayanan
4. Law of Intellectual Property, Asian Law House, Dr.S.R. Myneni.

CHAIRMAN/BOS DEAN (ACADEMIC) CHAIRMAN/ACADEMIC COUNCIL

VII Semester (2013-14)

COURSE TITLE : CONTROL ENGINEERING		
Sub Code: ME71	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/week : 04
Exam Duration:3hours		Exam Marks : 100

COURSE OBJECTIVES:

1. Model the mechanical, electrical, thermal, hydraulic and analogous systems through differential equations.
2. Analyze compensators and other modes and its allied mechanisms.
3. Emphasize on transient characteristics and response of the systems.
4. Define Routh-Hurwitz criteria and signal flow systems.
5. Demonstrate compensators, automatic controllers and electrical systems
6. Construct root locus, bode plots and Nyquist plots using MATLAB

#	Contents	h
UNIT-1	**INTRODUCTION**	**10**
	Concept of automatic controls, Open loop and closed loop systems, Concepts of feedback, requirements of an ideal control system. Mathematical Models**:** Transfer function models, models of mechanical systems, models of electrical circuits, DC and AC motors in control systems, models of thermal systems, models of hydraulic systems, pneumatic system, Analogous systems: Force voltage, Force current	
UNIT-2	**BLOCK DIAGRAMS AND SIGNAL FLOW GRAPHS**	**12**
	Transfer Functions definition, function, blocks representation of systems elements, reduction of block diagrams, Signal flow graphs: Mason's gain formula. **TRANSIENT AND STEADY STATE RESPONSE ANALYSIS:** Introduction, first order and second order system response to step, ramp and impulse inputs, concepts of time constant and its importance in speed of response. System stability: Routh's-Hurwitz Criterion; Types of controllers- Proportional, Integral Proportional Integral, Proportional Integral Differential controllers.	
UNIT-3	**FREQUENCY RESPONSE ANALYSIS**	**10**
	Polar plots, Nyquist stability criterion, Stability analysis, Relative stability concepts, Gain margin and phase margin, M&N circles	
UNIT-4	**FREQUENCY RESPONSE ANALYSIS USING BODE PLOTS**	**10**
	Bode attenuation diagrams, Stability analysis using Bode plots, Simplified Bode Diagrams	
UNIT-5	**ROOT LOCUS PLOTS**	**10**
	Root Loci; Definition, General rules for constructing and Analysis using root locus plots	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Describe fundamentals of control elements
2. Develop mathematical models of different mechanical and electrical systems.
3. Analyze steady state and transient response of first order and second order systems.

4. Analyze system stability through root locus and Bode plots.
5. Illustrate programming skills for control engineering in MATLAB environment

TEXT BOOKS:

1. **Modern Control Engineering,**KatsuhikoOgatta, Pearson Education,2004.
2. **Control Systems Principles and Design,**M.Gopal, TMH,2000.

REFERENCE BOOKS :

1. **Modern Control Systems**, Richard.C.Dorf and Robert.H.Bishop, Addison Wesley,1999
2. **System dynamics & control**, Eronini-Umez, Thomson Asia pte Ltd. singapore, 2002.
3. **Feedback Control System**, Schaum's series. 2001.

SCHEME OF EXAMINATION (Question Paper Pattern)

1. SEVEN full questions to be set
2. FIVE full questions to be answered
3. Questions from Unit 3, Unit 4 and Unit 5 are COMPULSORY
4. TWO questions with CHOICE from Unit 1 and Unit 2

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : THEORY OF PLASTICITY (CORE ELECTIVE)		
Sub Code: ME721	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/week : 03
Exam Duration:3hours		Exam Marks : 100
Prerequisite	Theory of Elasticity	

COURSE OBJECTIVES:

1. To make the student to understand the Fundamentals, plastic deformation,
2. Differentiate between true stress and strain, their relations,
3. Understand the concept of slip line field theory and beam bending to be discussed

#	Contents	h
UNIT-1	**Fundamental of Elasticity**	10
	Concept of stress, stress transformation laws, spherical and deviator stress tensors, equilibrium equations, octahedral stresses, concept of strain, deviator and spherical strain tensors, strain transformation laws, octahedral strains, generalized Hooke's law, elastic strain energy, compatibility equations, theories of strength. Numerical problems	
UNIT-2	**Plastic Deformation of Metals**	10
	Crystalline structure in metals, mechanism of plastic deformation and ? plane factors affecting plastic deformation, strain hardening, recovery, recrystallization and grain growth, flow figures or luder's cubes. Cubical dilation, true stress and strain: Strain tensor, principal strain, plane strain, spherical and deviator strain, octahedral strain and representative strain, problems.	
UNIT-3	**Stress-Strain Relations**	07
	Introduction, type of materials, empirical equations, theories of plastic flow, experimental verification of St.Venant's theory of plastic flow, the concept of plastic potential, the maximum work hypothesis, mechanical work for deforming a plastic substance	
UNIT-4	**Slip Line Field Theory**	06
	Introduction, basic equations for incompressible two dimensional flow, continuity equations, stresses in conditions of plain strain, convention for slip lines, solutions of plastic deformation problem, Geometry of slip line field, Properties of the slip lines, construction of slip line nets	
UNIT-5	**Bending of Beams**	06
	Analysis for stresses, Nonlinear stress strain curve, shear stress distribution, residual stresses in plastic bending, problems	

COURSE OUTCOMES:

1. Analyze plane stress and strain problems, behavior of the materials/component subjected to three dimensional stresses
2. Understand behavior of the material or component subjected to dynamic and static stresses (tensors)
3. Understand type of failure of materials/ component under various types of loading conditions

4. Micro structural studies of the material subjected to twinning

TEXT BOOKS:

1. 'Theory of Plasticity',Chakraborty 3rd Edition Elsevier.
2. 'Engineering Plasticity', W. Johnson and P. B. Mellor D Van N.O Strand Co. Ltd 2000

REFERENCE BOOKS:

1. Basic Engineering Plasticity, DWA Rees 1st Edition Elsevier.
2. Theory of Plasticity, Sadhu Singh, Khanna publisher.

SCHEME OF EXAMINATION (Question Paper Pattern)

1. SEVEN full questions to be set
2. FIVE full questions to be answered
3. Questions from Unit 3, Unit 4 and Unit 5 are COMPULSORY
4. TWO questions with CHOICE from Unit 1 and Unit 2

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	2	2	0	1	0	1	0	3	1	3	0
2	2	3	2	2	1	0	1	0	3	1	3	0
3	3	3	2	1	3	0	1	0	3	2	3	2
4	0	0	1	1	1	1	2	0	2	2	2	2

Strong-3, Medium-2, Weak-1

COURSE TITLE : PRODUCT DESIGN & MANUFACTURING (CORE ELECTIVE)		
Sub Code: ME722	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/week : 03
Exam Duration:3hours		Exam Marks : 100

COURSE OBJECTIVES:

1. Impart knowledge of mathematics, basic and applied sciences.
2. Ability to identify, formulate and solve mechanical engineering problems based on data interpretation, design, experiment and analysis of results.
3. Learn effective engineering communication.
4. Ability to work in teams on multi-disciplinary projects in industry and research organizations.
5. Develop awareness of the ethical, professional and environmental implications of work in a global and societal context.
6. Ability to self-learn modern engineering tools, techniques, skills and contemporary engineering practice, necessary for engineering work.

#	Contents	h
UNIT-1	**STAGES IN DESIGN PROCESS**	**10**
	Introduction to various stages of the design process: Formulation of problem, Generation of alternatives, Evaluation, Guided Redesign. Case study. **PRODUCT LIFE CYCLE** New product introduction: early introduction, increased product life. Life cycle management tools: System integration, QFD, House of quality, Pugh?s method, Pahl and Beitz method. Case studies.	
UNIT-2	**VALUE ENGINEERING**	**10**
	Introduction, nature and measurement of value.Value analysis job plan.Creativity and techniques of creativity.Value analysis test.Case studies. **CONCURRENT/ REVERSE ENGINEERING** Introduction, basic principles, components, benefits of concurrent engineering. Concept of reverse engineering	
UNIT-3	**MATERIAL SELECTION**	**07**
	Materials in design.The evolution of engineering materials. Design tools and material data. Function, material, shape and process. Material selection strategy, attribute limits, selection process, computer aided material selection. Case studies. **PROCESS SELECTION** Introduction. Process classification: shaping, joining and finishing. Systematic process selection. Ranking, process cost. Computer – aided process selection	
UNIT-4	**DESIGN FOR MANUFACTURE AND ASSEMBLY**	**06**
	Design for Manufacture and Assembly (DFMA). Reasons for not implementing DFMA.Advantages of DFMA with case studies. Design features and requirements with regard to assembly, production. Design for Manufacture in relation to any two manufacturing processes: machining and injection molding. Need, objectives	

UNIT-5	DESIGN FOR 'X'	06
	Introduction. Design for: Safety, packaging and storage, quality, reliability, energy conservation, environment, aesthetics, ergonomics, maintenance, recyclability and disposal. Case studies. **PATENTS, LIABILITY AND ETHIC**S Introduction.Protecting your design: patents, copyright, basic tools of design protection. Liability issues in product design. Ethical considerations.Examples/ case studies.	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. To apply knowledge of mathematics, science, and engineering design and conduct experiments, as well as to analyze and interpret data.
2. Tesign a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
3. Function on multidisciplinary teams identify, formulate and solve engineering problems. understand professional and ethical responsibility. communicate effectively.
4. Understand the impact of engineering solutions in a global, economic, environmental, and societal context.
5. Recognize the need to engage in life-long learning attain knowledge of contemporary issues use the techniques, skills, and modern engineering tools necessary for engineering practice.

TEXT BOOKS:

1. Karl T. Ulrich, Steven D. Eppinger Product Design & Development McGrawHill

REFERENCE BOOKS:

1. John M. Usher, Utpal Roy and H. R. Parasaei Integrated Product and Process Development Tata McGraw Hill
2. G. Boothroyd, P. Dewhurst and W. Knight Product Design for Manufacture and Assembly Marcel Dekker

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven full Questions to be set.
2. Five full Questions to be answered.
3. Unit-3, Unit-4 and Unit-5are compulsory, with one full question from each Unit.
4. Unit-1 and Unit-2: Two full questions to be set with choice

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : AUTOMOTIVE ENGINEERING (CORE ELECTIVE)		
Sub Code: ME723	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/week : 03
Exam Duration:3hours		Exam Marks : 100
Pre-requisites	Elements of Mechanical Engineering, Applied Thermodynamics	

COURSE OBJECTIVES:

1. To describe the basic systems and components of Automobiles.
2. To analyze Engines, other power generation modes and its allied mechanisms.
3. To emphasize on Fuel characteristics and Fuel flow systems.
4. To explain combustion phenomena and ignition systems.
5. To demonstrate Power transmission mechanisms.
6. To demonstrate Steering and Suspension systems.
7. To define super charging and Turbo charging.
8. To explain the body constructional details.

#	Contents	h
UNIT-1	**ENGINE COMPONENTS AND COOLING & LUBRICATION SYSTEMS**	**08**
	Spark Ignition (SI) & Compression Ignition (CI) engines, cylinder – arrangements and their relatives merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve and port timing diagrams, Types of combustion chambers for S.I. Engine and C.I. Engines, Compression ratio, methods of a Swirl generation, choice of materials for different engine components, engine positioning, cooling requirements, methods of cooling, thermostat valves, different lubrication arrangements. **FUELS, FUEL SUPPLY SYSTEMS FOR SI AND CI ENGINES** Conventional fuels, alternative fuels, normal and abnormal combustion, cetane and octane numbers.	
UNIT-2	**FUEL MIXTURE REQUIREMENTS FOR SI ENGINE**	**10**
	types of carburetors, C.D. & C.C. carburetors, multi point and single point fuel injection systems, fuel transfer pumps, Fuel filters, fuel injection pumps and injectors. **SUPERCHARGERS AND TURBOCHARGERS** Naturally aspirated engines, Forced Induction, Types of superchargers, Turbocharger construction and operation, Intercooler, Turbocharger lag	
UNIT-3	**IGNITION SYSTEMS**	**10**
	Battery Ignition systems, magneto Ignition system, Transistor assist contacts. Electronic Ignition, Automatic Ignition advance systems. **POWER TRAINS** General arrangement of clutch, Principle of friction clutches, Torque transmitted, Constructional details, Fluid flywheel, Single plate, multi-plate and centrifugal clutches. **GEAR BOX** Necessity for gear ratios in transmission, synchromesh gear boxes, 3, 4 and 5 speed gear boxes. Free-wheeling mechanism, planetary gears systems, over drives, fluid coupling and torque converters, Epicyclic gear box, principle of automatic transmission, calculation of gear ratios, Numerical calculations for torque transmission by clutches	

UNIT-4	**DRIVE TO WHEELS**	**06**
	Propeller shaft and universal joints, Hotchkiss and torque tube drives, differential, rear axle, different arrangements of fixing the wheels to rear axle, steering geometry, camber, king pin inclination, included angle, castor, toe in & toe out, condition for exact steering, steering gears, power steering, general arrangements of links and stub axle, over steer, under steer and neutral steer, numerical problems, types of chassis frames. **SUSPENSION SPRINGS** Requirements, Torsion bar suspension systems, leaf spring, coil spring, independent suspension for front wheel and rear wheel. Air suspension system	
UNIT-5	**BRAKES**	**05**
	Types of brakes, Mechanical compressed air, vacuum and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes, drum brakes, Antilock – Braking systems, purpose and operation of antilock-braking system, ABS Hydraulic Unit, Rear-wheel antilock & Numerical Problems. **AUTOMOTIVE EMISSION CONTROL SYSTEMS** Automotive emission controls, Controlling crankcase emissions, Controlling evaporative emissions, Cleaning the exhaust gas, Controlling the air-fuel mixture, Controlling the combustion process, Exhaust gas recirculation, Treating the exhaust gas, Air-injection system, Air-aspirator system, Catalytic converter, Emission standards- Euro and Bharat norms	

TEXT BOOKS

1. **Automotive mechanics,** William H Crouse & Donald L Anglin, 10th Ed. TMH 2007
2. **Automobile Engineering**, Vol I and II, Kirpal Singh, 2002.

REFERENCE BOOKS:

1. **Automotive mechanics: Principles and Practices**, Joseph Heitner, D Van Nostrand Company, Inc
2. **Fundamentals of Automobile Engineering,**K.K.Ramalingam, Scitech Publications (India) Pvt. Ltd.
3. **Automobile Engineering**, R. B. Gupta, SatyaPrakashan, 4thedn. 1984.

SYLLABUS FOR CIE:

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)
CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE):

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2		3		4	5

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven Full Questions to be set and Five full Questions to be answered.
2. Unit-1, Unit-4 and Unit-5 are compulsory, with one question from each Unit and from Unit-2 and Unit-3: Two questions to be set with choice

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Distinguish the types of fuels used in IC engines and categorise the types of transmissions and suspension systems used in modern automobiles.
2. Understand various sensors and actuators to actuate safety devices in automobiles.
3. Work on the design of combustion chambers.
4. Build the basic starter and generator devices.
5. Understand the working of Anti lock braking systems and GPS systems
6. Compare the various emission control systems.

MAPPING OF COs WITH POs

COs/POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : FRACTURE MECHANICS (CORE ELECTIVE)		
Sub Code: ME731	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/week : 03
Exam Duration:3hours		Exam Marks : 100

COURSE OBJECTIVES:

1. Analyze stress singularity at the crack tip through fracture parameters.
2. Derive the plastic zone at the crack tip.
3. Obtain the plastic zone size at the crack tip.
4. Discuss the fatigue crack propagation using damage tolerant design.
5. Analyze fracture behavior under different alloying conditions in a material.
6. Discuss different computational methods for fracture analysis.

#	Contents	h
UNIT-1	**FRACTURE MECHANICS PRINCIPLES**	**10**
	Introduction, Mechanisms of Fracture, a crack in structure, the Griffith's criterion, modern design – strengths, stiffness and toughness. Stress intensity approach. **STRESS ANALYSIS FOR MEMBERS WITH CRACKS:** Linear elastic fracture mechanics, Crack tip stress and deformations, Relation between stress intensity factor and fracture toughness, Stress intensity based solutions, measurement of fracture toughness(E399; ASTM). Crack tip plastic zone estimation, Plane stress and plane strain concepts. The Dugdale approach, the thickness effect.	
UNIT-2	**ELASTIC – PLASTIC FRACTURE MECHANICS**	**06**
	Introduction, Elasto–plastic factor criteria, crack resistance curve, J-integral, Crack opening displacement, crack tip opening displacement. Importance of R-curve in fracture mechanics, experimental determination of J-integral, COD and CTOD	
UNIT-3	**FATIGUE AND FATIGUE CRACK GROWTH RATE**	**07**
	Fatigue loading, various stages of crack propagation, the load spectrum, approximation of the stress spectrum, the crack growth integration, fatigue crack growth laws, Cumulative damage index, cycle counting method	
UNIT-4	**COMPUTATIONAL FRACTURE MECHANICS**	**10**
	Overview of numerical methods, traditional methods in computational fracture mechanics – stress and displacement marching, elemental crack advance, virtual crack extension, the energy domain integral, finite element implementation. Limitations of numerical fracture analysis.	
UNIT-5	**FRACTURE TOUGHNESS TESTING OF METALS**	**06**
	Specimen size requirements, test procedures, temperature effect, loading rate and plate thickness on fracture toughness. Fracture testing in shear modes, fatigue testing, NDT methods	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Define fundamental aspects of fracture mechanics
2. Express the governing equations for stress intensity factor, energy release rate, J-integral and CTOD.

3. Compute the crack tip stress field and growth behaviour for different load conditions
4. Discuss different computational models available for fracture analysis
5. Understand methods of preventing premature fatigue failure

TEXT BOOKS:

1. **Introduction to Fracture Mechanics**, Karen Hellan McGraw Hill Pub.2000
2. **Fracture of Engineering Brittle Materials,**Jayatilake, Applied Science, London.

REFERENCE BOOKS:

1. **Fracture Mechanics – Fundamentals and Application,**T.L. Anderson, CRC press 1998
2. **Elementary Engineering Fracture Mechanics**, David Broek, ArtinusNijhoff, London 1999.
3. **Fracture and Fatigue Control in Structures**, Rolfe and Barsom, Prentice Hall 2000.
4. **Fundamentals of Fracture Mechanics**, Knott, Bureworth 2000
5. **Fracture Mechanics, Prashanth Kumar.**

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven Full Questions to be set and Five full Questions to be answered.
2. Unit-2, Unit-3 and Unit-5 are compulsory, with one question from each Unit and from Unit-1 and Unit-4: Two questions to be set with choice

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : ADVANCED WELDING PROCESSES (CORE ELECTIVE)		
Sub Code: ME732	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/week : 03
Exam Duration:3hours		Exam Marks : 100

COURSE OBJECTIVES:

1. The student gains information on different solid state welding processes.
2. To understand the working principle, weld characteristics and process parameters of high energy beam welding.
3. To understand the working principle, advantages, disadvantages of elctroslag, electrogas welding, thermit welding.
4. To understand the process of thermal cutting of materials, brazing and soldering.

#	Contents	h
UNIT-1	**SOLID STATE WELDING PROCESSES**	**07**
	Friction and friction stir welding, ultrasonic welding, adhesive bonding, diffusion bonding, explosion welding- basic principle, process variables, weld characteristics advantages, limitations and applications	
UNIT-2	**HIGH ENERGY BEAM WELDING PROCESSES**	**06**
	Electron Beam Welding (EBW) - basic principle, equipment details, process characteristics, process variables, advantages, limitations and applications. Laser Beam Welding (LBW) – principle of operation, different laser mediums, advantages, limitations and applications	
UNIT-3	**ELECTRO SLAG AND ELECTRO GAS WELDING**	**10**
	Principle of operation, equipment details, process variations, advantages, limitations and applications. **THERMIT WELDING** Basic principle, thermit mixtures, applications	
UNIT-4	**THERMAL CUTTING**	**06**
	Oxy-Acetylene cutting-basic principle, metal powder cutting, chemical flux cutting, oxygen lancing; Arc cutting- brief introduction to oxygen/air / plasma / metal arc cutting arc cutting and gouging; advantages, limitations and applications of various techniques	
UNIT-5	**BRAZING AND SOLDERING**	**10**
	Introduction, brazing vs. soldering, various techniques, their advantages, limitations and applications; brazing & soldering consumables. **UNDERWATER WELDING** Introduction to wet and dry under water welding & cutting. **WELDING IN SPACE** Introduction, welding techniques, difficulties and advantages	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Describe the working principle, process characteristics, advantages, disadvantages and limitations of friction welding, friction stir welding, ultrasonic welding, adhesive boning, explosion welding and diffusion bonding.

2. Describethe mechanism, working principle and process characteristics of high energy beam welding.
3. Demonstrate with the mechanism, working principle and process characteristics of electroslag, electro gas welding and thermit welding, soldering, brazing, underwater welding .
4. Decide best cutting techniques for a particular application and their limitations.

TEXT BOOKS:

1. S.V.Nadkarni, "Modern Arc Welding Technology", Oxford & IBH.
2. R.Little, "Welding Technology, TMH. WELDING CODES AND STANDARDS ME-9111 L T P

REFERENCE BOOKS:

1. H.B.Cary, "Modern Arc Welding Technology", Englewood Cliffs, Prentice Hall.
2. Leonard P Connor, Welding Hand book, Volume I-III, AWS.
3. Metals Hand book , Volume 6, American Society of Metals.
4. Dave Smith, "Welding skills and technology", McGraw Hill.

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-2 and Unit-4are compulsory, with one full question from each Unit.
4. Unit-3 and Unit-5: Two full questions to be set with choice

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : ADVANCED HEAT TRANSFER (CORE ELECTIVE)		
Sub Code: ME733	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/week : 04
Exam Duration:3hours		Exam Marks : 100
Pre-requisites	Basic & Applied Thermodynamics, Fluid Mechanics, Heat Transfer	

COURSE OBJECTIVES:

1. To understand the heat conduction in solids with variable thermal conductivity and heat generation.
2. To solve steady and unsteady heat conduction problems using finite difference method.
3. To derive the differential equation of heat convection and solve problems related to flow over solids of different geometry.
4. To understand the heat transfer by natural convection and analyse the correlations for enclosed spaces to solve numerical problems.
5. To explain the phenomena of condensation and boiling and understand the correlations related to them.
6. To understand the mass transfer and different types of mass transfer.

#	Contents	h
UNIT-1	**HEAT CONDUCTION IN SOLIDS**	**07**
	The differential equation of heat conduction, Variable thermal conductivity, Heat generation, Two-dimensional steady state heat conduction, Unsteady state heat conduction processes, The finite difference method for solving steady and unsteady state heat conduction problems, Numericals.	
UNIT-2	**HEAT TRANSFER BY FORCED CONVECTION**	**06**
	The differential equation of heat convection, Laminar and turbulent flow heat transfer in a pipe, The thermal boundary layer, Heat transfer in laminar flow over a flat plate, The integral method, Analogy between heat and momentum transfer, Heat transfer in turbulent flow over a flat plate, Flow across a cylinder, Flow across banks of tubes, Numericals	
UNIT-3	**HEAT TRANSFER BY NATURAL CONVECTION**	**06**
	Introduction, Natural convection heat transfer from a vertical plate, Correlations for a horizontal cylinder and a horizontal plate, Correlations for enclosed spaces, Combined convection, Numericals.	
UNIT-4	**CONDENSATION AND BOILING**	**10**
	Introduction, Film and drop condensation, Film condensation on a vertical plate, Condensation on horizontal tubes, Effect of superheated vapour and of non-condensable gases, Type of boiling, Correlations in saturated pool boiling, Flow boiling, Numericals	
UNIT-5	**MASS TRANSFER**	**10**
	Introduction, Fick's law of diffusion, Steady state mass diffusion in a stationary medium, Diffusion in mixing medium, Convective mass transfer, Analogy between heat and mass transfer, Simultaneous heat and mass transfer, Numericals	

TEXT BOOKS

1. **A Text Book on Heat Transfer,** S.P. Sukhatme, 4th Edition, Universities Press, 2005.
2. **Heat and Mass Transfer,** P.K. Nag, 3rd Edition, Tata McGraw-Hill Publications, 2011.
3. **A Course in Heat and Mass Transfer,** Domkundwar, Arora, Domkundwar, DhanpatRai Publications, 2005.

REFERENCE BOOKS

1. **Heat and Mass Transfer**, Cengel,Y.A., and Ghajar, A.J., 4th Edition, McGraw-Hill Publications, 2011.
2. **Principles of Heat and Mass Transfer**, Frank P. Incropera, David P. Dewitt, Theodore L. Bergman, and Adrienne S. Lavine, 7th Edition, Wiley Student Edition, 2013.

e-LEARNING RESOURCES

1. **A Heat Transfer Text Book**, John H Leinard IV and John H Leinard V, 3rd Edition, Phlogiston Press, Cambridge, Massachusetts, USA, 2008.
2. **Heat and Mass Transfer: Mechanical Engineering Handbook**, Kreith, F., Boehm, R.F., et. al., Frank Kreith (Ed), Boca Raton: CRC Press LLC, 1999.
3. **Fundamentals of Heat and Mass Transfer**, Frank P. Incropera, David P. Dewitt, et. al. Frank P. Incropera (Ed), 6th Edition, John Wiley and Sons, 2007.
4. **e-Journal: Frontiers in Heat and Mass Transfer**, http://www.ThermalFluidsCentral.org
5. **Videos, Student slides, Handouts, Lecture notes:** http://www.nptel.ac.in

DATA HAND BOOK AND CHARTS

1. **Heat and Mass Transfer Data Hand Book,** C.P. Kothandaraman, S. Subramanyan, New Age International Publishers, 8th Edition, 2014.
2. **Steam Tables with Mollier Diagram: SI Units**, Mahesh M.Rathore, DhanpatRai Publishing Company, 2014.

SYLLABUS COVERAGE FOR CIE

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)
CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Describe conduction and convection heat transfer mechanisms, boiling, condensation and mass transfer.
2. Distinguish the heat and mass transfer modes with examples and illustrations.
3. Sketch and solve problems related to application of conduction, convection, boiling, condensation and mass transfer.
4. Compare and analyse different modes of heat transfer.
5. Derive mathematical expressions and equations to determine the heat and mass transfer rate.
6. Calculate the rate of heat and mass transfer and compute the performance of various heat and mass transfer systems.

MAPPING OF COs WITH POs

COs/POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	2	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : ENGINEERING TRIBOLOGY (CORE ELECTIVE)		
Sub Code: ME741	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/week : 03
Exam Duration:3hours		Exam Marks : 100

COURSE OBJECTIVES:

1. Describe the basic systems and components.
2. Analyze & Emphasize allied mechanisms.

#	Contents	h
UNIT-1	**INTRODUCTION TO TRIBOLOGY**	**05**
	Properties of oils and equation of flow: Viscosity, Newton's Law of viscosity, Hagen-Poiseuille Law, Flow between parallel stationary planes, viscosity measuring apparatus. Lubrication principles, classification of lubricants	
UNIT-2	**HYDRODYNAMIC LUBRICATION**	**06**
	Friction forces and power loss in lightly loaded bearing, Petroff's law, Tower's experiments, idealized full journal bearings. **MECHANISM OF PRESSURE DEVELOPMENT IN AN OIL FILM:** Reynold's investigations, Reynold's equation in two dimensions.Partial journal bearings, end leakages in journal bearing, numerical problems.	
UNIT-3	**SLIDER / PAD BEARING WITH A FIXED AND PIVOTED SHOE**	**08**
	Preliminary design of roller element bearings, Pressure distribution, Load carrying capacity, coefficient of friction, frictional resistance in a pivoted shoe bearing, influence of end leakage, numerical examples	
UNIT-4	**OIL FLOW AND THERMAL EQUILIBRIUM OF JOURNAL BEARING**	**10**
	Oil flow through bearings, self-contained journal bearings, bearings lubricated under pressure, thermal equilibrium of journal bearings. **HYDROSTATIC LUBRICATION:** Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing	
UNIT-5	**BEARING MATERIALS**	**10**
	Commonly used bearings materials, properties of typical bearing materials.Introduction to magnetic bearings & foil bearings. **WEAR:** Classification of wear, wear of polymers, wear of ceramic materials, wear measurements, effect of speed, temperature and pressure. **BEHAVIOR OF TRIBOLOGICAL COMPONENTS:** Selection, friction, Wear of ceramic materials, wear measurements, effects of speed, temperature and pressure. Tribological measures, Material selection, improved design, surface engineering	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Distinguish the types of bearings used and categorize them
2. Understand the various lubrication systems
3. Work on need based lubrication and bearing designs.

TEXT BOOKS:

1. **Fundamentals of Tribiology** , Basu S K., Sengupta A N., Ahuja B. B., , PHI 2006
2. **Introduction to TribiologyBearings,**Mujumdar B. C., S. Chand company pvt. Ltd 2008.

REFERENCE BOOKS:

1. **Theory and Practice of Lubrication for Engineers,** Fuller, D., New York company 1998
2. **Principles and Applications of Tribiology,** Moore, Pergamaon press 1998
3. **Tribiology in Industries,**Srivastava S., S Chand and Company limited, Delhi 2002.
4. **Lubrication of bearings – Theoretical Principles and Design,**Redzimovskay E I., Oxford press company 2000.

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-2 and Unit-3 are compulsory, with one full question from each Unit.
4. Unit-4 and Unit-5: Two full questions to be set with choice

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : INDUSTRIAL ROBOTICS (CORE ELECTIVE		
Sub Code: ME742	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/week : 03
Exam Duration:3hours		Exam Marks : 100

COURSE OBJECTIVES:

1. To understand the application of robots in an industry based on its structure
2. To understand the basic function of controllers
3. To analyze the position representation of points on various linkages with respect to other linkages using homogenous transportation matrices
4. To progress robots for pick-place using VAL-II
5. To understand the functions of vision system and applications for inspection in assembly

#	Contents	h
UNIT-1	**INTRODUCTION**	**08**
	AUTOMATION AND ROBOTICS: brief history of robotics. Social and economic aspects of robotics, advantages and disadvantages of using robots in industries.Overview of robots present and future applications.Classification and structure of robotic system: Classifications based on geometrical configurations. Wrist and its motions, end effectors and its types, links and joints. **ROBOT DRIVE SYSTEMS**:- Hydraulic, electric and pneumatic drive systems (to study only advantages and disadvantages), resolution, accuracy and repeatability, payload work volume	
UNIT-2	**CONTROL SYSTEMS AND COMPONENTS**	**06**
	Basic control system concepts and models, transformation and block diagram of spring mass system, controllers – ON and OFF, proportional integral, proportional and integral, transient and response to second order system. Robot Actuation and Feedback components: position. Sensors, Actuators	
UNIT-3	**ROBOT ARM KINEMATICS**	**10**
	KINEMATICS- Introduction, direct and inverse kinematics, rotation matrix, composite rotation matrix, relation between basic coordinates & rotary coordinates (PTP and CP motions), rotation matrix about an arbitrary axis, Euler angles representation. Homogeneous transformations, links, joints and their parameters.D-H representation. **ROBOT ARM DYNAMICS:** Lagrange – Euler formulations – Joint velocities, kinetic energy , potential energy and equations of a robot manipulator	
UNIT-4	**TRAJECTORY PLANNING**	**10**
	Introduction. General considerations on trajectory planning, joint interpolated trajectories, 4-3-4 trajectory example. Planning of Cartesian path Trajectories Robot programming**:** Introduction, manual teaching, lead through teaching, programming language – Victor Assembly Language- II and simple pallatization program, programming with graphics, storing and operating. Task programs.	

UNIT-5	SENSORS& VISION SYSTEMS	05
	Internal state sensors, tactile sensors, proximity sensing, range sensing, and force-torque sensors. Elements of computer vision. Sensing and digitizing function in machine vision – image devices – lighting techniques – analog to digital signal conversion- sampling- unitization – encoding- image storage. Image processing and analysis, Feature Extraction and Object recognition	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Explain the drives and control system required for various applications of robots.
2. To teach Homogeneous transformation, kinematic and dynamic analysis of robots
3. Identify Inverse kinematic and trajectory planning related problems.
4. Demonstrate the robot sensors and object recognition systems.

TEXT BOOKS:

1. Robotics by Fu and Gonsalvez

REFERENCE BOOKS:

1. Industrial Robotics by Mikell P Groover
2. Robotics by Yorenkoren

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-2 and Unit-5 are compulsory, with one full question from each Unit.
4. Unit-3 and Unit-4: Two full questions to be set with choice

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : SOLAR ENERGY ENGINEERING (CORE ELECTIVE)		
Sub Code: ME743	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/week : 03
Exam Duration:3hours		Exam Marks : 100
Pre-requisites	Basic Thermodynamics, Heat Transfer	

COURSE OBJECTIVES:

1. To provide opportunity for students to work on multidisciplinary projects.
2. To provide students with a sound foundation to formulate, solve and analyze basic Non – conventional energy problems and prepare them for graduate studies.
3. The objective is to familiarize the students with non-conventional energy sources and allied technological systems for energy conversion.
4. Focus is on solar energy conversion, Wind energy conversion and Bio- mass based energy conversion with their application perspective.
5. This course also serves the objective of imparting the importance of non-conventional energy conversion technologies in the present day energy crisis scenario.

#	Contents	h
UNIT-1	**INTRODUCTION**	**06**
	Energy source: renewable energy sources, renewable energy potential and achievements in India, General characteristics of solar energy; the Sun, solar spectrum, spectral solar impedance. **SOLAR RADIATION AT THE EARTH SURFACE** Solar constant beam, diffuse and global radiation.Solar radiation data of India. Measurement of solar radiation.Pyranometer, pyrheliometer, sunshine recorder (schematic diagram and working principles of devices.)	
UNIT-2	**SOLAR RADIATION GEOMETRY**	**06**
	Sun earth angles- latitude, declination, hour angle, zenith, solar altitude angle, surface azimuth angle, solar azimuth angle, Local apparent time, solar time, apparent motion of sun, day length, numerical examples. **SOLAR THERMAL RADIATION DEVICES** Liquid flat plate collectors, solar air heaters, concentrating collectors like cylindrical, parabolic, evacuated tubular collectors	
UNIT-3	**STORAGE DEVICES**	**10**
	Sensible heat storage, latent heat storage. Application of solar energy: water heating, space heating, space cooling, active and passive cooling systems. Various power generation methods; Solar furnace, Refrigeration, Distillation, Solar ponds; theory, working principle, operational problems (Sketches, principle of working). **SOLAR PHOTOVOLTAIC SYSTEM** Introduction, Description, Principles of working of solar cell:- Doping, Fermi level, p-n junction, photovoltaic effect. Photovoltaic Material:- Single crystal solar cell, Poly crystal solar cell, thin film solar cell, I-V characteristic, limits to cell efficiency, Cell temperature factors affecting PV cell performance Current status and Future potential of P.V. cells	

UNIT-4	**PERFORMANCE ANALYSIS OF LIQUID FLAT PLATE COLLECTORS**	**10**
	General description, collector geometry, selective surface (qualitative discussion), basic energy balance equation, stagnation temperature, transmissivity of the cover system, transmissivity-absorptivity product, numerical examples. The overall loss coefficient, correlation for the top loss coefficient, bottom and side loss- coefficient **TEMPERATURE DISTRIBUTION** Temperature distribution between the collectors tubes, collector heat removal factor, collector efficiency factor and collector flow factor, mean plate temperature, instantaneous efficiency (all expression to be provided). Effect of various parameters on the collector performance: Collector orientation, selective surface, fluid inlet temperature, number of covers, dust.	
UNIT-5	**SOLAR CONCENTRATORS**	**07**
	Introduction, characteristic parameters: Aperture area, Acceptance angle, absorber area, geometric concentration ratio. **TYPES, CLASSIFICATION, TRACKING** Concentration, Non tracking concentrator. Cylindrical parabolic, Hemispherical Bowl Mirror, V- trough. Tracking Methods:- Three Dimensional Concentrators, Two dimensional concentrators. Materials for concentrators: - Reflecting and Refracting surfaces, receiver cover and surface coating, working fluids, insulation; applications- solar pond/power packs in satellites.	

TEXT BOOKS:

1. Solar Energy- Principles of thermal collection and storage, S.P Sukhatme, TMH.
2. Solar Power Engineering, P. K. Nag THH 2003.

REFERENCE BOOKS:

1. Solar Engineering of thermal processes, Duffie, J.A. and Beckman, W.A., JWS (1991)
2. Solar Energy Utilization – G.D.Rai

SYLLABUS FOR CIE:

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)
CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE):

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1		2		3	4	5

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven full Questions to be set.
2. Five full Questions to be answered.
3. Unit-3, Unit-4 and Unit-5 are compulsory, with one full question from each Unit.
4. Unit-1 and Unit-2: Two full questions to be set with choice

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Demonstrate an understanding of the scientific principles of methodology of Non-conventional energy.
2. Acquire working knowledge of different Renewable energy science-related topics.
3. Design relative model systems based upon different energy conditions and also Specification of different environmental problems.
4. Apply design methodologies, including open and closed gasification system for all feed materials in biomass gasification
5. Analyze the system related concepts effectively in the wind energy designing.
6. Decide the appropriate procedures to ensure that the working model has developed properly

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	2	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : COMPUTER AIDED MODELING AND ANALYSISLABORATORY		
Sub Code: MEL75	No of Credits : L-T-P-SS 00:00:02:00 =01	No. of lecture hours/week : 02
Exam Duration:3hours		Exam Marks : 50

COURSE OBJECTIVES:

1. To be able to understand and handle design problems in systematic manner
2. To gain practical experience in 2D drafting and 3D modeling software systems.
3. To be able to apply CAD in real life applications.
4. 4.To be able to understand meaning and Usefulness of FEM
5. To be able to understand Various software used to solve the practical problems

#	Contents	h
UNIT-1	**Study of a FEA package and modeling stress analysis of**	**13**
	a. Bars of constant cross section area, tapered cross section area and stepped bar b. Trusses – (Minimum 2 exercises) c. Beams – Simply supported, cantilever, beams with UDL, beams with varying load etc (Minimum 6 exercises)	
UNIT-2	**Stress analysis of**	**13**
	a) Stress analysis of a rectangular plate with a circular hole b) Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions(Minimum 4 exercises) c) Dynamic Analysis 1) Fixed – fixed beam for natural frequency determination 2) Bar subjected to forcing function Fixed – fixed beam subjected to forcing function	

REFERENCE BOOKS:

1. A first course in the Finite element method, Daryl L Logan, Thomason, 3rd Ed.
2. Fundaments of FEM, Hutton – McGraw Hill, 2004
3. Finite Element Analysis, George R. Buchanan, Schaum Series

QUESTION PAPER PATTERN (SEE)

UNIT	1	2
Q. No.	Q1	Q2,

SCHEME OF EXAMINATION (SEE)

Sl. No.	Particulars	Max. Marks	Break Up of Max. Marks		
			Write Up	Conduction of experiment / Modelling Analysis	Conduc Expected Out Putt- Results (Different displacement, BM, Stress, Strain results. EtcandPlotting deformation diagram, SFD,BMD, Graph if it's required)
1	**Unit-1: Minor Experiment** (Any ONE from the list of experiments and it is purely individual Experiment) Q1	**15**	05	05	05
2	**Unit-2: Major Experiment** (Any ONE **Experiment** from the list of experiments and it is a Group Experiment) Q2	**25**	05	10	10
3	Viva Voce	**10**	—	—	—
	TOTAL MARKS	**50**	**10**	**25**	**15**

- Two Full Questions to be set.
- Students shall be to be answered two full Questions.
- Each question(Experiments contains different Marks and it is clearly mentioned in the above table)
- Changing of Experiments is not allowed from any unite if changing of experiments allowed 50% marks will be deducted.
- Viva Voce is compulsory

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Explore the Techniques of 2D and 3D Computer Aided Design (CAD)
2. Elaborate the applications and limitations of different Auto CAD, Micro Station, CATIA, Pro- E,I-DEAS,ExistingFEA software's (ANSYS, NISA, CAEFEM, Abaqus, Msc-Nastran, Optistruct / Radioss, Comsol-Multiphysics system types and their applications
3. Students will be able to solve a stress analysis problem theoretically, compare the same with results of the software and able to understand the importance of theoretical calculations.
4. students will be able to assign the different element types, properties and also material models to the structure being analyzed. and also students will be able to carry out static, dynamic thermal analysis using ansys to get required Output results.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	2	2	3	3	2	3	3	1	2
2	2	3	3	2	2	1	3	2	3	3	3	2
3	3	3	3	2	3	2	3	1	3	2	3	2
4	3	3	2	2	3	2	3	1	2	2	3	3

- **High-3**
- **Medium-2**
- **Low-1**

COURSE TITLE : PROJECT WORK PHASE - I		
Sub Code: MEP76	No of Credits : L-T-P-SS 00:00:00:08=00	No. of lecture hours/week : 00
Exam Duration : NA		Exam Marks : 50

COURSE OBJECTIVES:

1. To provide an amicable atmosphere for students to plan
2. To test their learned theory knowledge in an actual working situation
3. To discover the value of work and relish rewards of accomplishment
4. To ensure a professional preparation to the liberal educational goals.

The project proposal shall be presented in the following form.

#	Contents	h
UNIT-1	Definition of the problem	
UNIT-2	Exhaustive literature survey	
UNIT-3	Methodology	

The Project Proposal shall be submitted within 3 weeks from the start of the semester in the prescribed standard format (04 copies) to the HOD, after the certification of the concerned guide and HOD.
Minimum No. of students per batch: 02
Maximum No. of students per batch: 04
CIE Evaluation: Two seminars shall be conducted at the end of 6^{th} and 10^{th} week of the semester.

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Literature review on par with international journal standards
2. Literature gap determination and definition of the problem
3. Scientific Design / Numerical Analysis / Analytical model and interpret them
4. Apply tools / techniques for problem solving and prepare project work

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

VII I Semester (2013-14)

COURSE TITLE : HYDRAULICS AND PNEUMATICS		
Sub Code: ME81	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/week : 04
Exam Duration:3hours		Exam Marks : 100
Pre-requisites	Fluid Mechanics	

COURSE OBJECTIVES:

1. To explain the operation of the main elements of an industrial hydraulic and pneumatic system.
2. To define basic fluid power terms and units.
3. To identify Hydraulic and Pneumatic graphic symbols.
4. To describe fluid power components.
5. To calculate basic operations for sizing hydraulic and pneumatic components.
6. To perform basic fluid power maintenance procedures.

#	Contents	h
UNIT-1	**INTRODUCTION TO HYDRAULIC POWER**	**08**
	Definition of hydraulic system, advantages, limitations, applications, Pascal's law, structure of hydraulic control system, problems on Pascal's law. **PUMPS** Classification, Pumping theory of positive displacement pumps, construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps, Pump performance characteristics, pump Selection factors.	
UNIT-2	**HYDRAULIC ACTUATORS AND MOTORS**	**09**
	Classification cylinder and hydraulic motors, Linear Hydraulic Actuators [cylinders], single and double acting cylinder, Mechanics of Hydraulic Cylinder Loading, cushioning, special types of cylinders. **CONTROL COMPONENTS IN HYDRAULIC SYSTEMS** Classification of control valves, Directional Control Valves- ANSI Symbolic representation, constructional features of poppet, sliding spool, rotary type valves solenoid and pilot operated DCV, shuttle valve, check valves, Pressure control valves - types, direct operated types and pilot operated types. Flow Control Valves - compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation.	
UNIT-3	**HYDRAULIC CIRCUIT ANALYSIS**	**08**
	Control of Single and Double Acting Hydraulic Cylinder, Regenerative circuit, Pump Unloading Circuit, Double Pump Hydraulic System, Counter balance Valve Application, Hydraulic Cylinder Sequencing Circuits, Automatic cylinder reciprocating system, Locked Cylinder using Pilot check Valve, Cylinder synchronizing circuit using different methods, factors affecting synchronization, Speed Control of Hydraulic Motors, Safety circuit, Accumulators, types, construction and applications with circuits.	

UNIT-4	**INTRODUCTION TO PNEUMATIC CONTROL**	**13**
	Definition of pneumatic system, advantages, limitations, applications, Choice of working medium.Characteristic of compressed air. Structure of Pneumatic control System, fluid conditioners and FRL unit. **PNEUMATIC ACTUATORS** Linear cylinder - Types, Conventional type of cylinder- working, End position cushioning, seals, mounting arrangements- Applications. Rod - Less cylinders types, working, advantages, Rotary cylinders- types construction and application, symbols. **COMPRESSED AIR** Production of compressed air- Preparation of compressed air-Driers, Filters, Regulators, Lubricators, Distribution of compressed air Piping layout.	
UNIT-5	**PNEUMATIC CONTROL VALVES**	**14**
	DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve, Quick exhaust valve, time delay valve, shuttle valve, twin pressure valve, symbols. Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, speed control of cylinders - supply air throttling and Exhaust air throttling and Exhaust air throttling. **SIGNAL PROCESSING ELEMENTS** Use of Logic gates - OR and AND gates in pneumatic applications. Practical Examples involving the use of logic gates, Pressure dependant controls- types - construction - practical applications, Time dependent controls principle. Construction, practical applications. **ELECTRO- PNEUMATIC CONTROL** Principles - signal input and output, pilot assisted solenoid control of directional control valves, relay and contactors. Control circuitry for simple signal cylinder application.	

TEXT BOOKS:

1. **"Fluid Power with Applications",** Anthony Esposito**,**6th Ed., Pearson Education, Inc, 2000.
2. **'Pneumatics and Hydraulics',** Andrew Parr, JaicoPublilishing Co.

REFERENCE BOOKS:

1. **'Oil Hydraulic systems', Principles and Maintenance** S. R. Majurr, Tata McGraw Hill Publishing Company Ltd. - 2001
2. **'Industrial Hydraulics',Pippenger, Hicks"** McGraw Hill, New York
3. **'Hydraulic & Pneumatic Power for Production'**, Harry L. Stewart
4. **'Pneumatic Systems',** S. R. Majumdar, Tata McGraw Hill Publish 1995
5. **'Power Hydraulics'** Michael J Pinches & John G Ashby, Prentice Hall.

SYLLABUS COVERAGE FOR CIE:

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)
CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-2 and Unit-3 are compulsory, with one full question from each Unit.
4. Unit-4 and Unit-5: Two full questions to be set with choice

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Outline the basics of hydraulics and pneumatics.
2. Identify symbols and notations associated with hydraulics and pneumatics.
3. Solve simple numerical problems on operations.
4. Select basic fluid power maintenance procedures.
5. Design simple hydraulic and pneumatic circuits
6. Use hydraulics and pneumatics models for development of automatic systems.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	3	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : ENGINEERING DESIGN (CORE ELECTIVE)		
Sub Code: ME821	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/week : 03
Exam Duration:3hours		Exam Marks : 100

#	Contents	h
UNIT-1	**DESIGN PROCESS**	**10**
	Introduction, History of Design Process, Design by innovation, inadequacies of traditional design methods, product Design process, product cost, quality and time to market. **DETAILED DESCRIPTION OF DESIGN PROCESS:** Conceptual design, embodiment design, detail design, planning for manufacture, planning for distribution, planning for use planning for retirement, marketing, organization for design, designing to codes and standards, design renew product and process cycles, environmentally responsible design.	
UNIT-2	**NEED IDENTIFICATION AND PROBLEM DEFINITION**	**10**
	Introduction, identifying customer needs, gathering information from customers needs, generation of specifications. **CONCEPT GENERATION AND EVALUATION:** Introduction, creativity, problem solving, creativity methods, conceptual decomposition, Concept Generation Methods: Brain storming, 6-3-5 method, use of analogies, use of extremes and inverses, Morphological methods. Theory of inventive problem solving (TRIZ) **CONCEPT EVALUATION METHODS:** Based on feasibility judgment, assessment of technology readiness based on go-no-go screening, Pugh's method.	
UNIT-3	**EMBODIMENT DESIGN**	**08**
	Introduction product architecture, brief introduction to Configuration Design and parametric design. **DETAIL DESIGN**: Importance of Drawings, Drawings produced during Design process. Bill of materials: Brief introduction to modeling and simulations, prototypes and testing, rapid prototyping .Final Design Review.	
UNIT-4	**MATERIALS SELECTION AND MATERIALS IN DESIGN**	**06**
	Introduction, general criteria for material selection, performance characteristics of materials, material selection process, illustration of Ashby charts, methods of material selection, material performance indices, decision matrices, Pugh's selection method, Weighted property index method, Value analysis.	
UNIT-5	**DESIGN FOR X (DFX)**	**06**
	General introduction, Design for Manufacture (DFM):Introduction, DFM guidelines, Specific Design Rules. Design for Assembly(DFA): Introduction, DFA guidelines. Design for Reliability (DFR): Introduction, Bath-tub curve, Mean life, MTTF and MTBF, Failure rate(Constant and Variable), Exponential and Weibull reliability functions, System reliability concepts-Series and Parallel systems. Design for Environment (DFE):Introduction, DFE practices, Introduction to Design for Test and Maintenance(Serviceability),Introduction to Industrial Design. Cost Considerations and Human Factors in Engineering Design	

TEXT BOOKS

1. **Engineering Design: A Materials and Processing Approach:** George E. Dieter, McGraw Hill, 1991.
2. **The Mechanical Design Process**, David G. Ullman, McGraw Hill, 2003

REFERENCE BOOKS

1. **Product Design &Development:** Karl T. Ulrich & Steven D, Epinger, Tata McGraw Hill, 3rd Edition, 2003
2. **Engineering Design Principles:** Ken Hurst, Elsevier, 2010
3. **An introduction to Engineering Design Method:** V Gupta and P Murthy, TMH 2000
4. **Introduction of Engineering Design:** T. Woodson, McGraw Hill, 2001
5. **Design & Planning of Engineering systems:** D. D. Meredith, K.W. Wong, R.W. Woodhead& K. K.Worthman,2000
6. **Introduction to Design:** M.A. Asimov, Prentice Hall, 1996.
7. **Product Design and Manufacturing:** A.C. Chitale and R.C. Gupta, PHI 4TH edition 2007.

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Analyze the types of design and concepts
2. Applying the concept of need based design.
3. Implement preliminary design concept in real life.
4. Analyzing the process of design in the form of sequence of actions.
5. Apply the different types of designs like adequate, economic and optimal designs in to real life.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : FOUNDRY TECHNOLOGY (CORE ELECTIVE)		
Sub Code: ME822	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/week : 03
Exam Duration:3hours		Exam Marks : 100

COURSE OBJECTIVES:

1. To provide opportunity for students to get to know the basics of a foundry basics.
2. To provide a sound foundation on solidification, risering and gating which is the crux of a true foundry.
3. The objective is to familiarize the students with some out of the box molding techniques along with highlighting cupola firing.
4. Focus is on ferrous and non-ferrous metals and to choose suitable foundries for the same.
5. This course also serves the objective of parting the importance of foundry which cannot be foregone even with the advanced levels of manufacturing.

#	Contents	h
UNIT-1	**FOUNDRY METALLURGY**	**06**
	Oxidation of liquid metals, Gas dissolution in liquid metals, methods of degassing, fluidity, factors affecting fluidity, fluidity tests, hot tearing, shrinkage of liquid metals. **CASTING DESIGN:** Introduction to casting design, Redesign considerations, Design for minimum casting stresses, Design for directional solidification, Design for metal flow, Safety factors, Design for low pattern cost and model making as an aid in design, problems	
UNIT-2	**RISERING AND GATING**	**10**
	Need for risering, general considerations of risering, riser shapes, riser size, and location. Requirements of a riser.Sand, Insulating, and Exothermic materials used for risers.Riser feeding distance and Theory of risering.Internal chills, External chills, Use of mould materials of different chill capacities, padding for directional solidification. Open type and blind risers. Riser treatment using exothermic and Insulating compounds. **GATING SYSTEM** Theoretical consideration of gating, Laws of fluid flow, Turbulence in gating system, Use of ceramic foam filters in gating, Need for tapered sprue, Gating ratio, simple problems	
UNIT-3	**SOLIDIFICATION OF CASTINGS**	**11**
	Crystallization and Development of cast structure - Nucleation, Growth and Dendritic growth. Structure of castings - Significance and practical control of cast structure, Grain shape and Orientation, Grain size, Refinement and Modification of cast structure.Concept of progressive and directional solidification, Solidification time and derivation of Chovrinov's equation, Influence on mold characteristics and cast metal	
UNIT-4	**SPECIAL MOULDING TECHNIQUES**	**06**
	Principles, materials used, process details and application of no-bake sand systems, vacuum, flaskless and high pressure moulding	

	CUPOLA MELTING: Developments in cupola melting – hot blast, water cooled, balanced blast and cokeless cupola, cupola charge calculations.	
UNIT-5	**FOUNDRY**	**06**
	FERROUS: Melting procedures, casting characteristics, production, specification, and properties of some typical steels, grey cast iron, malleable iron, and spheroidal graphite cast iron castings. **NON-FERROUS:** Melting procedures, casting characteristics, production, specification, and properties of some typical aluminum, copper, and magnesium based alloy castings	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Demonstrate an understanding of the scientific principles of metallurgy and casting design.
2. Acquire working knowledge of solidification of metals and methods to enhance the same.
3. Design relative model systems for inflow of molten metal from ladles into the molds with safety norms to be taken to ensure complete filling of molds.
4. Analyse the system which are special or need based for some very peculiar situations and also the cupola furnace which is versatile.
5. Decide the appropriate method for ferrous or non-ferrous metals for a particular usage.

TEXT BOOKS:

1. **Principles of metal casting,** Heine Loper& Rosenthal TMH - 2005
2. **Principle of Foundry Technology**, P. L. Jain, TMH – 2006.

REFERENCE BOOKS:

1. **Castings,** John Campbell, Second edition, Elseivier.
2. **Foundry Technology,** P. N. Rao, Tata McGraw Hill, 21 st Reprint 2007.
3. **Manufacturing Process-**I, Dr. K. Radha Krishna 5thEdn. Sapna Book House, Bangalore.

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven Full Questions to be set and Five full Questions to be answered.
2. Unit-1, Unit-4 and Unit-5 are compulsory, with one question from each Unit and from
   Unit-2 and Unit-3: Two questions to be set with choice

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : BIOMASS ENERGY SYSTEMS (CORE ELECTIVE)		
Sub Code: ME823	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/week : 03
Exam Duration:3hours		Exam Marks : 100
Pre-requisites	Applied Thermodynamics	

COURSE OBJECTIVES:

1. To understand biomass and its conversion methods
2. To analyze chemical conversion methods
3. To know about gasification and in turn methanization
4. To know the role of biogas and biodiesel in power generation
5. To look into possibilities on bio power plant set-up

#	Contents	h
UNIT-1	**INTRODUCTION**	**10**
	Biomass energy sources, energy content of various Bio – fuels, Energy plantation, origin of Biomass photo synthesis process, Biomass Characteristics, sustainability of Biomass. **BIOMASS CONVERSION METHODS:** Agrochemical, Thermochemical, Biochemical (flowchart) & Explanation.	
UNIT-2	**PHYSICAL & AGROCHEMICAL CONVERSION**	**05**
	Briquetting, Pelletization, Agrochemical, fuel Extraction, Thermo chemical Conversion: Direct combustion for heat, Domestic cooking & heating.	
UNIT-3	**BIOMASS GASIFICATION**	**06**
	Chemical reaction in gasification, Producergas& the constituents, Types of gasifiers, Fixed bed gasifiers, Fluidized bed gasifiers. Liquefaction: Liquefaction through pyrolysis & Methanol synthesis, application of producer gas in I C Engines	
UNIT-4	**BIO METHANIZATION**	**08**
	Anaerobic digestion, Basic principles, factors influencing Biogas yield, classification of Biogas digester, floating gasholder & fixed dome type.(Working Principle with diagram), Calculations for sizing the Biogas plant. **BIOGAS FOR POWER GENERATION:** Ethanol as an automobile fuel, Ethanol production & its use in engines	
UNIT-5	**BIO – DIESEL**	**10**
	Bio Diesel from edible & non-edible oils, Production of Bio diesel from Honge&Jatropha seeds, use of bio diesel in I C engines, Engine power using Bio diesel, Blending of Bio diesel, Performance analysis of diesel engines using bio diesel. Effect of use of bio diesel in I C engines. **BIO POWER PLANTS:** Bio Power generation routes, Basic Thermodynamic cycles in Bio power generation; Brayton cycle, Sterling cycle, Rankine cycle, Co-generation cycle. Biomass based steam power plant.	

TEXT BOOKS:

1. **Bio Gas Technology,** B.T. Nijaguna. New Age International- New Delhi.2001-02
2. **Energy Technology,** S. Rao& B. B. Parulekar – Khanna Publishers, Delhi-1999.
3. **Non Conventional Energy Sources,** G. D. Rai - Khanna Publishers. Delhi.

REFERENCE BOOKS:

1. **Greenhouse Technology for Controlled Environment,** G.N. Tiwari, Alpha Science International Ltd., Pangbourne.England.
2. **Renewable Energy Resources,** John.W.Twidell, Anthony. D. Weir, EC BG-2001.
3. **BioMass, Deglisc. X and P. Magne,** Millennium Enterprise, New Delhi.

SYLLABUS FOR CIE:

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)
CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1		2	3	4	5	

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven full Questions to be set.
2. Five full Questions to be answered.
3. Unit-2, Unit-3 and Unit-4 are compulsory, with one full question from each Unit.
4. Unit-1 and Unit-5: Two full questions to be set with choice

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Describe biomass energy sources and various methods of biomass energy conversion.
2. Illustrate the process of gasification leading to methanization.
3. Show that biogas is a source for power generation.
4. Infer bio-diesel as a source of power generation.
5. Develop bio power plant set-up with bio fuels.
6. Relate the advantages of biomass energy resources with other types of energy resources.

MAPPING OF COs WITH POs

COs/POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : OPERATIONS RESEARCH(CORE ELECTIVE)		
Sub Code: ME831	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/week : 03
Exam Duration:3hours		Exam Marks : 100

COURSE OBJECTIVES:

1. Explain the historical development of OR and its areas of applications.
2. Formulate the mathematical model of managerial problems like product mix etc.
3. Solve the problems where the variables are linear in nature by graphical method and simplex method.
4. Formulate and solve balanced and unbalanced Transportation problems.
5. Formulate and solve assignment problem.
6. Draw the project network diagram and schedule the project.
7. Analyze queuing system and find its parameters.
8. Formulate two person-zero sum game.
9. Find the best strategy for the given game by graphical and dominance methods

#	Contents	h
UNIT-1	**INTRODUCTION**	**06**
	Evolution of OR, definition of OR, scope of OR, application areas of OR, steps (phases) in OR study, characteristics and limitations of OR, models used in OR, linear programming (LP) problem-formulation and solution by graphical method. **SOLUTION OF LINEAR PROGRAMMING PROBLEMS**: The simplex method-canonical and standard form of an LP problem, slack, surplus and artificial variables	
UNIT-2	**TRANSPORTATION PROBLEM**	**10**
	Formulation of transportation problem, types, initial basic feasible solution using different methods, optimal solution by MODI method, degeneracy in transportation problems, application of transportation problem concept for maximization cases. Assignment Problem-formulation, types, application to maximization cases and travelling salesman problem.	
UNIT-3	**PERT-CPM TECHNIQUES**	**10**
	Introduction, network construction - rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects	
UNIT-4	**GAME THEORY**	**06**
	Formulation of games, types, solution of games with saddle point, graphical method of solving mixed strategy games, dominance rule for solving mixed strategy games. **SEQUENCING:** Basic assumptions, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines	

UNIT-5	REPLACEMENT PROBLEMS	07
	A) Replacement of items deteriorating with time, when money value remains same. B) Replacement of items which fail suddenly a. Individual replacement policy b. Group replacement policy **QUEUING THEORY:** Queuing systems and their characteristics, Pure-birth and Pure-death models (only equations), empirical queuing models – M/M/1	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Define models for linear programming
2. Convert the linear variable problems to a mathematical model and depict by graphical method.
3. Apply artificial variable technique to solve a linear programming model.
4. Compute the minimum cost of transportation by Modi's method and Hungarian method.
5. Design a project network diagram and schedule the project activities and duration.
6. Illustrate the strategies of different players in a game and find the best strategy by graphical and dominance method

TEXT BOOKS

1. **Operations Research,** P K Gupta and D S Hira, Chand Publications, New Delhi - 2007
2. **Operations Research,** Taha H A, Pearson Education

REFERENCE BOOKS

1. **Operations Research,** A P Verma, S K Kataria&Sons, 2008
2. **Operations Research,** Paneerselvan, PHI
3. **Operations Research,** A M Natarajan, P Balasubramani, Pearson Education, 2005
4. **Introduction to Operations Research,** Hiller and Liberman, McGraw Hill.

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven Full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-4 and Unit-5 are compulsory, with one question from each Unit.
4. Unit-2 and Unit-3: Two questions to be set with choice.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : NANO –TECHNOLOGY (CORE ELECTIVE)		
Sub Code: ME832	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/week : 03
Exam Duration:3hours		Exam Marks : 100

COURSE OBJECTIVES:

1. To acquire the basic knowledge of nanomaterials, their processes and applications
2. To encompass knowledge about carbon Nanotubes, gas phases clusters.
3. To be familiar about nanoshells, nano sensors and nanomedicines.
4. To be acquainted with processing of nanomaterials.

#	Contents	h
UNIT-1	**AN OVERVIEW OF NANOSCIENCE & NANOTECHNOLOGY**	**10**
	Historical background – nature, scope and content – multidisciplinary aspects – industrial, economic and societal implications. **EXPERIMENTAL TECHNIQUES AND METHODS** for investigating and manipulating materials in the nano scale – electron microscope – scanning probe microscope – optical and other microscopes – light scattering – x-ray diffraction. **FULLERENES –** discovery, synthesis and purification – chemistry of fullerenes in the condensed phase – orientational ordering – pressure effects – conductivity and superconductivity – ferromagnetism – optical properties.	
UNIT-2	**CARBON NANOTUBES**	**07**
	synthesis and purification – filling of nanotubes – mechanism of growth – electronic structure – transport properties – mechanical and physical properties – applications. **SELF-ASSEMBLED MONOLAYERS** monolayers on gold – growth process – phase transitions – patterning monolayers – mixed monolayers – applications. **GAS PHASE CLUSTERS** history of cluster science – formation and growth – detection and analysis – type and properties of clusters – bonding in clusters., Application of carbon Nanotubes.	
UNIT-3	**SEMI-CONDUCTOR QUANTUM DOTS**	**06**
	Synthesis – electronic structure of nanocrystals – how quantum dots are studied – correlation of properties with size – uses. **MONOLAYER-PROTECTED METAL NANOPARTICLES** – method of preparation–characterization – functionalized metal nanoparticles – applications – super lattices. **CORE-SHELL NANOPARTICLES** – types – characterization – properties – applications	
UNIT-4	**NANOSHELLS**	**10**
	Types – characterization – properties – applications.	

	MOLECULAR NANOMACHINES covalent and non-covalent approaches – molecular motors and machines – other molecular devices – single molecular devices – practical problems involved. **NANOBIOLOGY** Interaction between biomolecules and nanoparticle surfaces – materials used for synthesis of hybrid nano-bio assemblies – biological applications – nano probes for analytical applications – nanobiotechnology – future perspectives. **NANOSENSORS** what make them possible – nano scale organization for sensors – characterization – nano sensors based on optical properties – nano sensors based on quantum size effects – electrochemical sensors – sensors based on physical properties – nano biosensors – sensors of the future. **NANOMEDICINES** approach to development – nanotechnology in diagnostic and therapeutic applications. **NANOTRIBOLOGY** studying tribology on the nanoscale – applications.	
UNIT-5	**PROCESSING OF NANO-TECHNOLOGY**	**06**
	Tool, mask based, Requirement for machine tool for producing Nano-Composites, difference between conventional and Nano-machining. **NANO-FABRICATION** Processes– Lithography, Etching, LIGA, Photochemical machining, Ion beam machining	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Describe and explain Nanotechnology.
2. Describe Nanomaterials based on their dimensionality.
3. Explore the methods of synthesis, fabrication and characterization of nanomaterials.
4. Explain top-down approaches for Nanomaterial fabrication, and give some examples.
5. Explain bottom-up approaches for Nanomaterial fabrication, and give some examples.
6. Describe and discuss Nanotechnology tools.
7. Give examples on the use of Nanotechnology in biomedical applications.
8. Give examples on the use of Nanotechnology in optical applications.
9. Give examples on the use of Nanotechnology in microelectronics applications.
10. Apply the basic knowledge in different fields of engineering for development of devices.

TEXT BOOKS:

1. **NANO: The Essentials – Understanding Nanoscience and Nanotechnology;**
   T Pradeep (Professor, IIT Madras); Tata McGraw-Hill India (2007)

2. **Nanotechnology:** Richard Booker & Earl Boysen; Wiley (2005).

REFERENCE BOOKS:

1. **Introduction to Nanoscale Science and Technology [Series: Nanostructure Science and Technology],** Di Ventra, et al (Ed); Springer (2004)
2. **Nanotechnology Demystified,** Linda Williams & Wade Adams; McGraw-Hill (2007)
3. **Introduction to Nanotechnology,** Charles P Poole Jr, Frank J Owens, Wiley India Pvt. Ltd., New Delhi, 2007.

SCHEME OF EXAMINATION (Question Paper Pattern)

1. SEVEN full questions to be set
2. FIVE full questions to be answered
3. Questions from Unit 2, Unit 3 and Unit 5 are COMPULSORY
4. TWO questions with CHOICE from Unit 1 and Unit 4.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1
7	3	3	2	1	2	1	1	1	1	2	1	1
8	3	3	3	1	2	1	1	1	1	2	1	1
9	3	3	3	1	3	1	1	1	1	3	1	1
10	3	3	3	1	2	1	1	1	1	1	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : COMPUTATIONAL FLUID DYNAMICS(CORE ELECTIVE)		
Sub Code: ME833	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/week : 03
Exam Duration:3hours		Exam Marks : 100
Pre-requisites	Basic Thermodynamics, Fluid Mechanics, Heat Transfer	

COURSE OBJECTIVES:

1. To understand the fundamentals of CFD and fluid flow equations in conservation forms.
2. To explain finite difference method and approximations used in this method.
3. To understand the finite volume and finite element methods of discretizing the partial differential equations.
4. To know the various methods of grid generation and solving the differential equations.
5. To understand the concept of viscous compressible flow and related equations.

#	Contents	h
UNIT-1	**INTRODUCTORY CONCEPTS**	**07**
	Introduction: Conservation equations; Mass, momentum and energy equations; Conservative forms of the equations and general description; Classification and Overview of Numerical Methods: Classification into various types of equations – parabolic, elliptic and hyperbolic; Boundary and initial conditions; Overview of numerical methods	
UNIT-2	**FINITE DIFFERENCE METHOD**	**06**
	Introduction, finite difference approximations, Taylor series expansion, polynomial fitting, approximation of boundary conditions, applications to conduction and advection-diffusion problems	
UNIT-3	**FINITE VOLUME AND FINITE ELEMENT METHODS**	**06**
	Finite Volume Method: Basic methodology, finite volume discretization, approximation of surface and volume integrals, interpolation methods – central, upwind and hybrid formulations and comparison for convection-diffusion problem; Finite Element Method: Introduction to Rayleigh-Ritz, Galerkin and least square methods, interpolation functions, one and two dimensional elements, applications.	
UNIT-4	**GRID GENERATION AND SOLUTION METHODS**	**10**
	Introduction; Classification; Principles of structured mesh generation; Structured grid generation techniques; Unstructured mesh generation; Adaptive mesh generation; Solution of finite difference equations, iterative methods, matrix inversion methods, ADI method, operator splitting, fast Fourier transform, applications; Time integration Methods: Single and multilevel methods; predictor-corrector methods; stability analysis; Applications to transient conduction and advection-diffusion problems	
UNIT-5	**VISCOUS COMPRESSIBLE FLOW**	**10**
	Navier-Stokes Equations: Explicit and implicit methods; SIMPLE type methods; fractional step methods; Phase Change Problems: Different approaches for moving boundary, variable time step method, enthalpy method; Turbulence modeling: Reynolds averaged Navier-Stokes equations, RANS modeling, DNS and LES.	

TEXT BOOKS:

1. **Computational Fluid Dynamics: The Basics with Applications,** John D. Anderson, Jr., McGraw-Hill International Editions, 1995.
2. **Computational Fluid Flow and Heat Transfer,** K. Muralidhar and T.Sundararajan (Editors), 2^{nd} Edition, Narosa Publishing House, 2003.
3. **Computational Fluid Dynamics: An Introduction**, John F. Wendt (Editor), Springer (India) Pvt. Ltd., 3^{rd} Edition, 2007.

REFERENCE BOOKS:

1. **Computational Fluid Methods for Fluid Dynamics**, J.H. Ferziger and M. Peric, Springer (India) Pvt. Ltd., 3^{rd} Edition, 2002.
2. **Introduction to Computational Fluid Dynamics**, PradipNiyogi, S.K. Chakrabartty, M.K. Laha, Pearson Education, 2011.
3. **Numerical Heat Transfer and Fluid Flow**, Suhas V. Patankar, Hemisphere Publishing Corporation, 1980.

e-LEARNING RESOURCES

1. **Videos, Lecture notes:** http://www.nptel.ac.in

SYLLABUS FOR CIE:

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)
CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE):

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Describe the different flow models, physical boundary conditions and governing equations suited for CFD.
2. Illustrate the applications of finite differences in partial differential equations with examples.
3. Sketch and explain the structured, unstructured and adaptive meshes used in the CFD analysis.
4. Compare and differentiate the various CFD techniques used in the finite volume method.
5. Derive expressions of governing equations for viscous and inviscid flows.
6. Relate the various modeling, mesh generation and CFD techniques used in viscous and inviscid flows.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	2	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : ENGINEERING SYSTEM DESIGN (CORE ELECTIVE)		
Sub Code: ME841	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/week : 03
Exam Duration:3hours		Exam Marks : 100

COURSE OBJECTIVES:

1. To study the basic concepts of different types of design.
2. Need analysis in engineering systems
3. Analyze the concept of design with respect to economics and optimization.

#	Contents	h
UNIT-1	**INTRODUCTION MORPHOLOGY OF DESIGN**	**10**
	INTRODUCTION: What is designing, Man as a designer: Design by evolution, inadequacies of traditional design method: System approach of engineering problems: Need models: design history of large scale existing system. Morphology of Design: The three phases of design projects, the structure of design process, decision making and iteration.	
UNIT-2	**IDENTIFICATION, NEEDANALYSIS &DESIGN CONCEPT**	**07**
	Preliminary need statement, analysis of need, specifications, and standards of performance and constraints.Process of idealization, mental fixity, analysis, AIDA, brain storming etc	
UNIT-3	**PRELIMINARY DESIGN**	**06**
	Mathematical modeling for functional design: concept of sensitivity, compatibility and stability analysis. Evaluation Of Alternatives And Design Decisions	
UNIT-4	**DESIGN TREE**	**06**
	Quality of design, Concept of utility, multi criteria decisions,decisions under uncertainty and risk (Numerical), Bath tub curve, exponential reliability function, system reliability concept. (Numerical)	
UNIT-5	**ECONOMICS AND OPTIMIZATION**	**10**
	Economics and Optimization in Engineering design: Economics in Engineering Design, Fixed and variable costs, break-even analysis. (Numerical) Optimization: Introduction to LPP. Man Machine Interaction, Designing for use and maintenance, Man-Machine Cycle, Design of displays and controls. Factors influencing displays and controls	

COURSE OUTCOMES:

1. Analyze the types of design and concepts
2. Applying the concept of need based design.
3. Implement preliminary design concept in real life.
4. Analyzing the process of design in the form of sequence of actions.
5. Apply the different types of designs like adequate, economic and optimal designs in to real life.

TEXT BOOKS:

1] MECHANICAL SYSTEM DESIGNBY : W. E. EDERand 'W. GOSLING, PERGAMON PRESS :OXFORD ,LONDON ,EDINBURGH ,NEW YORK ,PARI,'FRANKFURT.

2] Harrison Kim, Dept. of Industrial and Enterprise Systems Engineering (ISE) - 2 - 1. Papalambros, P.Y. and Wilde, D., Principles of Optimal Design (2nd Ed.), Cambridge University Press, New York, 2000. 2.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	2	2	2	0	3	0	3	1	3	2
2	2	3	3	2	1	0	3	0	3	2	3	2
3	3	3	2	3	3	0	3	0	3	2	3	2
4	3	3	2	1	3	1	3	1	2	2	3	3
5	3	1	1	2	2	1	3	1	3	2	3	2

Strong-3, Medium-2, Weak-1

COURSE TITLE : COMPOSITE MATERIALS AND MANUFACTURING (CORE ELECTIVE)		
Sub Code: ME842	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/week : 03
Exam Duration:3hours		Exam Marks : 100

COURSE OBJECTIVES:

1. Understand capabilities and limitations of existing materials and processes.
2. Define property enhancement mechanisms.
3. To understand the fundamentals of composite material strength and its mechanical behavior
4. Understanding the analysis of fiber reinforced Laminate design for different combinations of plies with different orientations of the fiber.
5. Determine opportunities for improvement.
6. Select materials and processes to best suit specific applications.
7. To develop knowledge on processing, interfacial properties and application of composites
8. An ability to predict the elastic properties of both long and short fiber composites based on the constituent properties.

#	Contents	h
UNIT-1	**INTRODUCTION**	**07**
	General introduction to composites; historical background; concept of matrix and reinforcement and particulates. **MATRIX AND REINFORCEMENT** Types of matrix and reinforcement, volume fraction and weight fraction Fiber architecture fiber packing arrangements, whiskers	
UNIT-2	**FABRICATION METHODS OF POLYMER COMPOSITES**	**07**
	Liquid resin impregnated routes, pressurized consolidation of resin pre-pegs, consolidation of resin molding compounds, injection molding of thermoplastics, hot press molding of thermoplastics	
UNIT-3	**FABRICATION OF CERAMIC COMPOSITES**	**10**
	Powder based routes, reactive processing, layered ceramic composites, carbon/carbon composites, **FABRICATION ROUTES OF METAL MATRIX COMPOSITES** Squeeze infiltration, stir casting, spray deposition, powder blending and consolidation, diffusion bonding of foils, PVD	
UNIT-4	**TESTING AND CHARACTERIZATION**	**10**
	Different tests like internal stress measurement by diffraction, metallographic preparation etc with special emphasis to metal matrix composites **SECONDARY PROCESSING AND APPLICATION OF COMPOSITES** Secondary processing like machining, joining, extrusion of composites; Application and case studies.	
UNIT-5	**SMART MATERIALS**	**05**
	Introduction and properties of piezoelectric materials, shape memory alloys, ER and MR fluids, electrostrictive and magntostrictive materials as smart materials, applications	

COURSE OUTCOME: On completion of the course, student should be able to**;**

1. To study matrix material, particulates and fibres of polymer matrix composites, MMC and ceramic matrix composites.
2. An ability to identify the properties of fiber and matrix materials used in commercial composites, as well as some common manufacturing techniques.
3. An understanding of how composites are used in the design of structures and Understand composite material and processing requirements for optimizing composite performance.
4. An ability to understand and select suitable processes for fiber reinforced, metal matrix composites and ceramic composites.
5. An ability to test and characterize the composites with more emphasis metal matrix composites.
6. An ability to process composites through secondary processing techiniques such as machining, joining and extrusion.

TEXT BOOKS:

1. S.C.Sharma Composite materials Narosa Publishers

REFERENCE BOOKS:

1. R.K.Everret& R.J. Arsenault Metal matrix composite Academic press
2. T. W. Clyne& P. J. Withers Introduction to metal Matrix Composite Cambridge press

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-2 and Unit-5 are compulsory, with one full question from each Unit.
4. Unit-3 and Unit-4: Two full questions to be set with choice

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	2	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : INTERNAL COMBUSTION ENGINES (CORE ELECTIVE)		
Sub Code: ME843	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/week : 03
Exam Duration:3hours		Exam Marks : 100
Pre-requisites	Basic and Applied Thermodynamics	

COURSE OBJECTIVES:

1. To understand the basic principle of thermodynamic process
2. To understand the basic components and structure of IC engines (both SI and CI engines), process parameters
3. Understanding the performance of the engine, combustion and exhaust parameters

#	Contents	h
UNIT-1	**CARBURETION**	**07**
	Introduction, Definition, Factors affecting carburetion, Air-fuel mixture, Mixture requirement, Principle of carburetion, Simple carburetor, Calculation of air-fuel ratio, Essential parts of a carburetor, Compensating devices, Additional systems in modern carburetors, Types of carburetors, Automobile carburetors, Altitude compensation, Numericals.	
UNIT-2	**INJECTION SYSTEMS**	**06**
	Introduction, Functional requirements, Classification, Fuel feed pump, Injection pump, Injection pump governor, Mechanical and pneumatic governor, Fuel injector, nozzle, Injection in SI engine, Numerical problems, Gasoline injection, Electronic fuel injection system, Multipoint fuel injection system, Functional divisions of MPFI system, Electronic control system, Injection timing, Group gasoline and electronic diesel injection system, Injection control.	
UNIT-3	**COMBUSTION AND COMBUSTION CHAMBERS**	**06**
	Introduction, Homogeneous and heterogeneous mixture, Combustion and its stages in SI and CI engine, Flame front propagation, Factors influencing the flame speed, Rate of pressure rise, Abnormal combustion, Factors affecting the delay period, Adiabatic flame temperature, Phenomenon of knock in SI and CI engine, Effect of engine variable in knock, Combustion chambers for SI and CI engine, Combustion and its stage in CI engine, Comparison of knock in SI and CI engine.	
UNIT-4	**MEASUREMENT AND TESTING OF PERFORMANCE PARAMETERS**	**10**
	Introduction, Measurement of friction power, indicated power, brake power, fuel and air consumption, Speed, Exhaust and coolant temperature, Emission, Noise and Combustion parameters; Engine efficiencies, Performance characteristics, Factors affecting performance, Methods of improving engine performance, Heat balance, Performance maps, Analytical method of performance estimation, Numericals.	
UNIT-5	**NON CONVENTIONAL ENGINES**	**10**
	Introduction, Construction, working principle and design of CRDI engine, Dual fuel and multi-fuel engine, Free piston engine, Gasoline Direct Injection engine, HCCI engine, Lean burn engine, Stirling engine, Stratified charge engine, VCR engine and Wankel engine	

TEXT BOOKS

1. **Internal Combustion Engines**, V. Ganesan, Tata Mc-Graw Hill Publications, 4th Edition, 2012.
2. **Internal Combustion Engines,** M. L. Mathur and R. P. Sharma, DhanpatRai Publications, 2014.

REFERENCE BOOKS

1. **Internal Combustion Engine Fundamentals,** John B. Heywood, Mc-Graw Hill Education India Limited, 2011.
2. **Engineering Fundamentals of the Internal Combustion Engines**, Willard W. Pulkrabek. Pearson Education, 2nd Edition, 2015.
3. **A Text Book of Internal Combustion Engines**, R.K. Rajput, Laxmi Publishers, 2007.

SYLLABUS FOR CIE

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)
CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Describe the carburetion and combustion processes with examples.
2. Explain the fuel injection systems in IC engines.
3. Sketch the combustion chambers in IC engines with illustrations.
4. Evaluate the performance parameters of IC engines.
5. Derive the performance characteristics of engines.
6. Summarize the non-conventional engines in the context of modern developments.

MAPPING OF COs WITH POs

COs/POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : DESIGN FOR MANUFACTURING AND ASSEMBLY (CORE ELECTIVE)		
Sub Code: ME851	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/week : 03
Exam Duration:3hours		Exam Marks : 100

#	Contents	h
UNIT-1	**TOLERANCES, LIMITS & FITS**	**12**
	TOLERANCE GRADES, LIMITS fundamental derivation, Fits, Tolerance, cumulative effect of tolerances in assembly. Relationship between attainable tolerance grades and different machining processes. **GEOMETRIC TOLERANCES:** Geometrical characteristics and symbols.Definition and Measurement of circularity, cylindricity, flatness and runout.True position tolerance. **SURFACE ROUGHNESS:** Terminology, Terms used for surface roughness, measurement of surface roughness. Surface roughness values obtained from various machining processes	**06**
UNIT-2	**CUMULATIVE EFFECT OF TOLERANCES**	
	sure fit law and truncated normal law. Selective assembly and interchangeable part manufacture, Control of axial play by introducing secondary machining processes and by adding laminated shims.	**05**
UNIT-3	**STASTICAL QUALITY CONTROL**	
	Frequency distribution, standard deviation concept of skewness&Kurtosh variance, Process capability, Indices C_p and C_{pk} control charts	
UNIT-4	**COMPONENT DESIGN FROM CASTING CONSIDERATIONS**	**06**
	Pattern, Mould, Parting line, cored holes and machined holes, Design for reducing/eliminating sand cores.	
UNIT-5	**DESIGN CONSIDERATIONS**	
	Major Design Phases. Design for Manufacturability consideration. Influence of Fabrication properties (Machinability, Castability, Weldability, Polymer processing). **SELECTION OF MATERIALS IN DESIGN:** Properties of Materials used in design. Material selection process – cost per unit property, weighted properties and limits on properties methods	**10**

TEXT BOOKS:

1. **Design for Manufacture,** Harry Peck, Pitman Publications,1983.
2. **Engineering Metrology,** R.K. Jain Khanna Publishers, 2000.

REFERENCE BOOKS:

1. **ASM Handbook, vol.20, Material** selection & Design.
2. **Design for Manufacturability Handbook,**Jamesh G. Baralla, Editor, TMH 1998.

3. **Product Design for Manufacture and Assembly,** GeofferyBoothroyed et a
4. **Engineering Design: A Materials and Processing Approach,**Geaorge. E. Dieter, McGraw Hill, 1991.

COURSE OUTCOME: On completion of the course, student should be able to;

1. Analyze the types of design and concepts
2. Applying the concept of need based design.
3. Implement preliminary design concept in real life.
4. Analyzing the process of design in the form of sequence of actions.
5. Apply the different types of designs like adequate, economic and optimal designs in to real life.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : INSPECTION AND QUALITY CONTROL(CORE ELECTIVE)		
Sub Code: ME852	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/week : 03
Exam Duration:3hours		Exam Marks : 100

COURSE OBJECTIVES:

1. The student should learn different inspection procedures objectives followed in industry and economic aspects.
2. To impart definition of quality, components, concepts and different approaches followed like quality circles, cost of quality and economic considerations in quality.
3. To impart fundamentals of statistical quality control, and process capability
4. To impart different sampling techniques
5. To impart knowledge on various quality standards followed

#	Contents	h
UNIT-1	**INDUSTRIAL INSPECTION**	**08**
	Objectives and functions of inspection in industry, production/ inspection interaction, organization for industrial inspection, inspection procedures, economic aspect of inspection	
UNIT-2	**CONCEPT OF QUALITY IN ENGINEERING**	**10**
	Meaning and significance of quality; essential components of quality; phases or elements for building quality; evolution of the concepts of quality; spiral of progress of quality; changing scope of quality activities; Ishikawa's seven quality tools; Quality Circles; Quality system economics, hidden quality costs; economic models of quality costs.	
UNIT-3	**QUALITY CONTROL FUNCTION**	**10**
	Inspection versus quality control techniques, quality planning activities, organization for quality control. Fundamentals of statistical quality control, Juran's quality trilogy Charts for variables and attributes, application of control charts for averages, range, standard deviation, fraction defectives and number of non conformities per unit, Process capability analysis	
UNIT-4	**ACCEPTANCE SAMPLING**	**08**
	Elementary concepts, sampling by attributes, single, double and multiple sampling plans, construction and use of operating characteristic curves	
UNIT-5	**QUALITY MANAGEMENT SYSTEMS**	**03**
	Introduction to various quality standards	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. The student will have the knowledge of inspection activity and functions that are followed in industry.
2. The student can carry out different quality procedures using different quality tools like quality circles, determine quality costs.
3. The student is in a position to construct control charts using data available in an industry, can also dwell upon the status of a process whether in control or out of control and find number of defectives.
4. The student can carry out sampling techniques with an industrial application.
5. Understand various quality systems prevalent in industry.

TEXT BOOKS

1. Juran, J. M. and Gryna, F. M., Quality Planning & Analysis, Tata McGraw Hill, New Delhi (1995).
2. Grant, E. L., Statistical Quality Control, McGraw Hill International, New York (2005).

REFERENCE BOOKS

1. Feignbaum, A. V., Total Quality Control, McGraw Hill International, New York (1991).
2. Besterfield, D.H., Total Quality Management, Pearson Education Asia, New Delhi (2003)

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-4 and Unit-5 are compulsory, with one full question from each Unit.
4. Unit-2 and Unit-3: Two full questions to be set with choice

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : HEAT TRANSFER IN ELECTRONIC EQUIPMENT (CORE ELECTIVE)		
Sub Code: ME853	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/week : 03
Exam Duration:3hours		Exam Marks : 100
Pre-requisites	Basic Thermodynamics, Heat Transfer	

COURSE OBJECTIVES:

1. To understand the fundamentals of semiconductor technology trends and the thermal design process..
2. To explain microelectronic package types and the resistance network associated with them.
3. To understand the conduction heat transfer mechanism in electronic equipment.
4. To know the fluid dynamics involved in the various electronic devices and how the forced convection affects the heat transfer rate.
5. To understand the mode of natural convection heat transfer and other cooling technologies used in industries to dissipate heat transfer from electronic equipment.

#	Contents	h
UNIT-1	**INTRODUCTORY CONCEPTS**	**07**
	Semiconductor technology trends, Temperature dependent failures, Importance of heat transfer in electronics, Thermal design process; Heat transfer mechanisms – conduction, convection and radiation heat transfer, Theoretical power dissipation in electronic equipment – Active and passive devices, Thermal resistance network – concept, series and parallel layers, General network, Contact resistance, Thermal interface materials, Spreading thermal resistance, Thermal resistance of PCBs, Numericals.	
UNIT-2	**MICROELECTRONIC PACKAGES**	**06**
	Importance of packaging, Packaging types, Thermal specification of microelectronic packages, Package thermal resistance network, Parameters affecting thermal characteristics of a package; Fin equation, Fin thermal resistance, effectiveness and efficiency, Fins with variable cross section, Heat sink thermal resistance, effectiveness and efficiency, Heat sink manufacturing processes, Numericals	
UNIT-3	**CONDUCTION HEAT TRANSFER IN ELECTRONIC EQUIPMENT**	**06**
	One dimensional heat conduction equation, General heat conduction equation, Boundary and initial conditions, One- and two-dimensional steady state heat conduction, Transient heat conduction, Lumped systems and validity of lumped system analysis, Numericals.	
UNIT-4	**FLUID DYNAMICS AND FORCED CONVECTION HEAT TRANSFER IN ELECTRONIC EQUIPMENT**	**10**
	Type of flows, Viscous force, Velocity boundary layer, Friction coefficient, Thermal boundary layer and convection heat transfer coefficient, Conservation equations, Boundary layer equations, Forced convection external flow: Reynolds number, Prandtl number, Eckert number and Nusselt number, Drag force, Flow over a flat plate with uniform temperature and uniform heat flux, Flow across cylinders, Cylindrical pin-fin heat sink, Procedure for solving external forced convection problems; Internal flow: Mean velocity and mean temperature, Laminar and turbulent pipe flows, Entry length and Fully developed flow, Pumping power and convection heat transfer coefficient, Velocity profiles and friction factor correlations, Fans and pumps – Types, Fan curve and system impedance curve, Fan selection, Plate-fin heat sinks, Numericals.	

UNIT-5	NATURAL CONVECTION HEAT TRANSFER AND ADVANCED COOLING TECHNOLOGIES	10
	Buoyancy force and natural convection flows, natural convection velocity and temperature boundary layers, Grashof and Raleigh numbers, Functional form of convection heat transfer coefficient, Laminar and turbulent natural convection over a vertical flat plate, around inclined and horizontal plates, vertical and horizontal cylinders, in enclosures, from array of vertical plates, Mixed convection, Numerical problems; Heat pipes – limits, applications, selection and modeling, thermosyphons, Loop heat pipes and vapour chambers, Liquid cooling, Thermoelectric coolers, Electrohydrodynamic flow, Synthetic jet.	

TEXT BOOKS

1. **Heat Transfer: Thermal Management of Electronics**, YounesShabany, CRC Press, Special Indian Edition, 2010.
2. **Heat and Mass Transfer: Fundamentals and Applications**, Cengel,Y.A., and Ghajar, A.J., 5th Edition, McGraw-Hill Publications (SIE), 2015.

REFERENCE BOOKS

1. **Thermal Design of Electronic Equipment (Electronics Handbook Series)**, Ralph Remsburg, CRC Press, 2001.
2. **Fundamentals of Microsystem Packaging,** Rao R. Tummala**,** McGraw Hill, 2001.

SYLLABUS FOR CIE

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)
CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Describe the importance of heat transfer in electronic equipment and thermal design in semiconductor technology trends.
2. Illustrate the thermal resistance network with respect to various microelectronic packages.
3. Explain the mode of conduction heat transfer in electronic equipment with neat sketches.
4. Analyse the fluid dynamic aspects and forced convection mode of heat transfer in electronic equipment.
5. Derive and develop various expressions and correlations for different modes of heat transfer occurring in electronic components.

6. Estimate the heat transfer rate from electronic components for their efficient working and performance over a given period.

MAPPING OF COs WITH POs

COs/POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	2	1	1	1	1	2	1	1
6	3	3	3	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : SUBJECT SEMINAR		
Sub Code: MES86	No of Credits : L-T-P-SS 00:00:04:00 =02	No. of lecture hours/week : 04
Exam Duration : NA		Exam Marks : 50

COURSE OBJECTIVES:

1. To equip students for making a technical presentation based on a thorough research review on any contemporary area of Engineering and Management fields
2. Offering the student an opportunity to interact with faculty and peer group and to build the ability to making independent presentation.

#	Contents	h
UNIT-1	Seminar shall be presented during 8^{th} / 9^{th} week of the semester in the department before the Departmental Evaluation Committee constituted by HOD.	**24**
UNIT-2	The seminar marks are to be awarded by the committee.	**14**
UNIT-3	Students shall submit the seminar report in the prescribed standard format.	**14**

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Conduct literature survey on a current topic based on peer reviewed literature
2. Identify research gap in the literature
3. Develop methodologies to resolve the identified problem(s)
4. Develop presentation slides / report arranging the material coherently
5. Present and discuss the topic with clarity and confidence and submit the report
6. Summarize the presentation and identify scope for further work

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	2	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : PROJECT WORK PHASE – II		
Sub Code: MEP87	No of Credits : L-T-P-SS 02:00:08:04=08	No. of lecture hours/week : 10
Exam Duration:3hours		Exam Marks : 100

COURSE OBJECTIVES:

1. To provide an opportunity and atmosphere in which students may test theory learned in the classroom in an actual working situation and discover the value of work and the rewards of accomplishment
2. To insure a natural transition to the higher level of professional preparation as a complement to the liberal education goals of the Institution.

The project report shall be presented in the following form.

#	Contents	h
UNIT-1	Analysis based on type of problem.	**30**
UNIT-2	Conclusions, scope for further work.	**90**
UNIT-3	References.	**10**

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Perform literature review on par with international journal standards
2. Identify literature gap and define the problem
3. Design Experiments scientifically / Perform Numerical Analysis / Develop Analytical models
4. Interpret the Experimental / Numerical / Analytical Results
5. Apply advanced tools / techniques for solving the problem
6. Prepare quality document of project work

CIE EVALUATION:

Two presentations shall be conducted at the end of 6th and 10th week of the semester. The Project Report shall be submitted in the prescribed standard format (04 copies) to the HOD, after the certification of the concerned guide and HOD.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	2	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

BATCH 2016– 2020(PROPOSED)
3rd Semester

			L	T	P	C
1	MA31	Engineering Mathematics III	4	0	0	4.0
2	ME31	Fluid Mechanics	4	0	0	4.0
3	ME32	Basic Thermodynamics	4	0	0	4.0
4	ME33	Mechanics Of Materials	4	0	0	4.0
5	ME34	Manufacturing Process - I	4	0	0	4.0
6	ME35	Metrology & Measurements	3	0	0	3.0
7	MEL36	Computer Aided Machine Drawing	2	0	4	4.0
8	MEL37	Manufacturing Process Laboratory -I	0	0	2	1.0
9	MEL38	Metrology & Measurements Laboratory	0	0	2	1.0
		THIRD SEMESTER END CREDITS				**29.0**

BATCH 2016– 2020(PROPOSED)
4th Semester

			L	T	P	C
1	MA41	Engineering Mathematics IV	4	0	0	4.0
2	ME41	Turbo Machines	4	0	0	4.0
3	ME42	Applied Thermodynamics	4	0	0	4.0
4	ME43	Kinematics Of Machines	4	0	0	4.0
5	ME44	Manufacturing Process - II	4	0	0	4.0
6	ME45	Material Science & Metallurgy	3	0	0	3.0
7	MEL46	Material Testing Laboratory	0	0	2	1.0
8	MEL47	Manufacturing Process Laboratory - II	0	0	2	1.0
9	MEL48	Fluid Mechanics & Machinery Laboratory	0	0	2	1.0
		FOURTH SEMESTER END CREDITS				**26.0**
		SECOND YEAR CUMULATIVE CREDITS				**105.0**

III Semester (2016-17)

COURSE TITLE :ENGINEERING MATHEMATICS-III		
Course Code : MA31	Number of Credits: 4 = 4 : 0 : 0 (L : T : P)	No. of lecture hours/ week : 04 (L=4)
Exam Duration: 3 Hrs	Exam Marks: CIE + Assignment + SEE = 45 + 5 + 50 = 100	Total No. of lecture hours: 50

Course objectives:

To introduce applied concepts in mathematics which will be beneficial to the students of all engineering courses.

Unit No.	Syllabus	No.of hours
1.	**Fourier Series**: Periodic functions, Dirichlet's conditions, Fourier Series ofperiodic functions with period 2π and with arbitrary period $2l$. Fourier series ofeven and odd functions. Half range Fourier Series and complex Fourier series. Applications-frequency spectrum and practical harmonic analysis.	10
2.	**Fourier Transforms:** Fourier transforms (infinite), Inverse Fourier Transforms. Properties-linearity, change of scale, shifting and modulation. Fourier transform of derivatives and convolution JKJAtheorem,(no proofs). Fourier sine and cosine Transforms. Applications- Fourier transforms to Initial-Boundary Value Problems (IBVP).	10
3.	**Z-Transformations:** Formation of difference equation, Definition of Z-transform and Z-transforms of some standard functions. Properties-linearity, change of scale, shifting, multiplication by n, initial and final value theorem. Inverse Z-transforms, convolution theorem. Applications-solutions of difference equations using Z-transforms.	10
4.	**Numerical Methods-I:** Roots of transcendental and polynomial equations using Bisection method, Regula-falsi method and Newton-Raphson method. Interpolation: Finite differences,Newton's forward and backward interpolation, Lagrange's and Newton's divided difference formula forunequal intervals. Inverse interpolation formula.	10
5.	**Numerical Methods-II :** Numerical differentiation, Numerical integration-Trapezoidal, Simpson's one third andthree-eighth, Weddle rules. Solution of ordinary differential equations (first and second order) by Euler's modified, fourth-order Runge-Kutta methods. Solution of system of linear equations-Jacobi and Gauss-Seideliterative methods.	10

Course Outcomes:

After the successful completion of the course, the students are able to

CO1: analyze the basic concepts of Fourier series, Integral Transforms and Numerical Methods.

CO2: use the techniques akin to Fourier and Z-transformations for solving the problems of Engineering field like continuous and discrete-time signal processing.

CO3: construct the model for periodic signals and to analyze the circuits and stability of communication systems.

CO4: compare the viability of different approaches to numerical solutions of problems arising in finding roots of equations, interpolation and approximation, numerical differentiation and integration, and solution of ODE's.

CO5: develop a variety of numerical algorithms using appropriate technology/ programminglanguages.

Course Outcomes (CO) Mapping with Programme Outcomes (PO)

CO1: PO1, PO2

CO2: PO1, PO2

CO3: PO1, PO2

CO4: PO1, PO2

CO5: PO1, PO2

TEXT BOOKS

1. B.S. Grewal, Higher Engineering Mathematics (Latest Edition, 2016), Khanna Publishers, New Delhi.

2. Erwin Kreyszig, Advanced Engineering Mathematics (10th Edition, 2016), Wiley Publishers, New Delhi.

REFERENCE BOOKS/Web sources:

1. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill publications, New Delhi.
2. H.K.Dass and Er. RajnishVerma, Advanced Engineering Mathematics (Latest Edn, 2015),S.Chand Publisher, New Delhi.
3. Dennis G Zill, MihaelGulle, Advanced Engineering Mathematics (2nd Edition), CBS publishers.
4. Glyn James, Advanced Modern Engineering Mathematics (fourth edition, 2011), Pearson's Publisher.
5. Andrei D. Polyanin and Alexender V. Manzhirov, Chapman & Hall/CRC, Taylor & Francis Group, New York.

QUESTION PAPER PATTERN:

The Semester End Examination (SEE) is for 100 marks.

1. There shall be five full questions (one question for each unit) carrying 20 marks each and all are Compulsory.

2. There shall be internal choice in Unit 2 and Unit 3

Note: Two Assignments are evaluated for 5 marks: Assignment – I from Units 1 and 2. Assignment – II from Units 3, 4 and 5.

COURSE TITLE : FLUID MECHANICS		
Course Code : ME31	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/ week : 04
Exam Duration: 3 Hrs	CIE +Assignment + SEE = 45 + 5 + 50 =100	Exam Marks : 100
Pre-requisites	Engineering Physics, Engineering Mathematics	

Course objectives:

1. To explain various properties of fluids related to fluid mechanics.
2. To determine hydrostatic force and centre of pressure on plane and curved sur-faces, locate metacentre and meta centric height of floating bodies.
3. To understand different types of pressure measurement devices.
4. To apply laws of conservation of momentum, mass and energy to fluid flow sys-tems and explain the measurement of fluid flow parameters.
5 .To interpret compressibility of gases in terms of Mach number.
6. To apply dimensional analysis and similarity laws for conducting model tests.

Unit No.	Syllabus	No.of hours
1.	**PROPERTIES OF FLUID** Introduction, classification of fluids, properties of fluids, viscosity, thermodynamic properties, surface tension, capillarity, vapour pres-sure, cavitation phenomenon.Numerical problems. FLUID STAT-ICS**:** Fluid pressure at a point, Pascal's law, pressure variation in a static fluid, absolute, gauge, atmospheric and vacuum pressures, simple manometers and differential manometers. Total pressure and center of pressure on submerged plane surfaces; horizontal, vertical and inclined plane surfaces, curved surface submerged in liquid. Numericals	**10**
2.	**BUOYANCY** Buoyancy, center of buoyancy, metacentre and metacentric height, conditions of equilibrium of floating and submerged bodies, de-termination of Metacentric height experimentally and theoreti-cally. Numerical problems. KINEMATICS: Types of fluid flow, continuity equation in 2D and 3D (Cartesian Co-ordinates only), velocity and acceleration, Numerical problems. FLUID DYNAMICS**:** Introduction, Equation of motion, Euler's equation of motion, Bernoulli's equation from first principles and also from Euler's equation, limitations of Bernoulli's equation. Numericals	**10**

3.	**FLUID FLOW MEASUREMENTS** Applications of Bernoulli's equation, Venturimeter, orificemeter, pitot-tube, vertical orifice, V-Notch and rectangular notches, Numerical problems.Navier-stoke's Equation. DIMENSIONAL ANALYSIS: Introduction, derived quantities, dimensions of physical quantities, dimensional homogeneity, Rayleigh's method, Buckinghamp theorem, dimensionless numbers, similitude, types of similitude, dimensional analysis and similarity studies. Numericals	10
4.	**FLOW THROUGH PIPES** Introduction, major and minor losses through pipes. Darcy's and Chezy's equation for loss of head due to friction in pipes.HGL and TEL. Numerical problems. LAMINAR FLOW AND VISCOUSEFFECTS: Reynold's number, critical Reynold's number, laminar flow through circular pipe-Hagen Poiseille's equation, laminar flow between parallel and stationary plates. Numericals.	10
5.	**FLOW PAST IMMERSED BODIES AND COMPRESSIBLE FLOW** Introduction, Drag, Lift, expression for lift and drag, boundary layer concept, displacement, momentum and energy thickness. Numerical problems. INTRODUCTION TO COMPRESS-IBLE FLOW: introduction – stagnation properties relationship, Velocity of sound in a fluid, Mach number, Mach cone, propagation of pressure waves in a compressible fluid. Numerical.	10

TEXT BOOKS

1. A Textbook of Fluid Mechanics and Hydraulic Machines (SI Units), Dr.R.K. Bansal, Laxmi Publications (P) Limited, Revised 9th Edition,, 2010.

2.Hydraulics and Fluid Mechanics including Hydraulic Machines, Dr. P.N.Modi and S.M. Seth, Rajsons Publications Private Limited, Standard Book House, 2009.

REFERENCE BOOKS

1. Fluid Mechanics: Fundamentals and Applications (SI Units),Yunus A.Cengel, JohnM. Cimbala. McGraw-Hill Publications (SIE), 3rd Edition, 2014.

2. Fluid Mechanics, Frank M. White, McGraw-Hill Publications (SIE),7th Edition, 2011.

e-LEARNING RESOURCES

1. Fluid Mechanics: Mechanical Engineering Handbook, Kreith,F, Berger, S.A,et. al., Ed. Frank Kreith, Boca Raton: CRC Press LLC, 1999.

2. Videos and Lecture Notes: http://www.nptel.ac.in

SYLLABUS COVERAGE FOR CIE

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)
CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4	5		

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q6 and Q7 from Unit1, Unit4 and Unit 5 respectively without choice.
2. Students shall answer Q2 or Q3 from Unit 2 and Q4 or Q5 from Unit3.
3. Each question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES:

On completion of the course, student should be able to; After completion of the course, students will be able to:

1. Define and describe fluid properties, define buoyancy and related laws, list the types of fluid flow and flow measuring devices, define non dimensional numbers, and describe concept of boundary layer.
2. Illustrate the laws of fluid mechanics with suitable examples; explain the different types of manometers and distinguish various equations of motion.
3. Apply the various equations and solve numerical problems related to fluid statics, kinematics and dynamics, laminar and viscous effects and compressible flow.
4. Compare the different types of flow measuring devices, analyze dimensions of physical quantities, classify flow types and evaluate non dimensional numbers.
5. Derive the equations of motion and other flow related equations, and develop various mathematical relations relevant to various flow regimes.
6. Calculate the various parameters for the given numerical problems.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : BASIC THERMODYNAMICS		
Course Code : ME32	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/ week : 04
Exam Duration: 3 Hrs	CIE +Assignment + SEE = 45 + 5 + 50 =100	Exam Marks : 100
Pre-requisites	Engineering Physics, Engineering Mathematics	

Course objectives:

1. To understand the fundamental concepts of thermodynamic system, process and cycle.
2. To explain work and heat transfer with illustrations and examples.
3. To interpret First and Second law of thermodynamics in the context of closed and opne system.
4. To understand the concept of entropy and the principle of increase of entropy.
5. To solve problems related to thermodynamic system applying the various thermodynamic relations to pure substances and gases.

Unit No.	Syllabus	No.of hours
1.	**FUNDAMENTAL CONCEPTS** Macroscopic and microscopic viewpoint, Thermodynamic system and control volume, Thermodynamic property, process and cycle, Homogeneous and heterogeneous system, Thermodynamic equilibrium, Quasi-static process, Pure substance, Concept of continuum, Thermostatics, Units and dimensions; Zeroth law of thermodynamics, Measurement of temperature, Comparison of thermometers, Ideal gas, Gas thermometers, Ideal gas temperature, Celsius temperature scale, electrical resistance thermometer, Thermocouple, International Practical Temperature Scale; Work transfer, pdV work – Path function and point function, pdV work in various quasi-static processes, Indicator diagram, Other types of work transfer, Free expansion with zero work transfer, Net work done by a system, Heat transfer, Heat transfer as a path function, Specific heat and latent heat, Comparison of heat and work transfer, Numericals	08
2.	**FIRST LAW OF THERMODYNAMICS** First law of a closed system undergoing a cycle (Joule's experiment) and undergoing a change of state, Energy as a property of a system, Forms of stored energy, Specific heat at constatn volume and constant pressure, Enthalpy, Energy of an isolated system, PMM 1, Limitations of the First law; Application of First law to flow processes – Control volume, Steady flow process, Mass and energy balance in a simple steady flow process, Examples of steady flow processes, Comparison of SFEE with Euler and Bernoulli equations, Variable flow processes with examples, Discharging and charging a tank, Numericals.	10
3.	**SECOND LAW OF THERMODYNAMICS** Qualitative difference between heat and work, Cyclic heat engine, Energy reservoirs, Kelvin-Planck and Clausius statement of Second law of thermodynamics, PMM 2, Refrigerator and heat pump, Equivalence of Kelvin-Planck and Clausius statements, Reversibility and irreversibility, Causes and conditions of irreversibility, Carnot cycle, Reversed heat engine, Carnot's theorem and its Corollary, Absolute thermodynamic temperature scale, Efficiency of the reversible heat engine, Equality of ideal gas and Kelvin temperatures, Types of irreversibility, Numericals.	10
4.	**ENTROPY AND THERMODYNAMIC RELATIONS** Introduction, Clausius theorem, The property of entropy, T-s plot, Clausius inequality, Entropy change in an irreversible process, Entropy principle and its applications, Entropy transfer mechanisms, Entropy generation in a closed and open system, T-ds relations, Reversible adiabatic work in a steady flow system, Entropy and direction, Entropy and disorder; Thermodynamic relations – Maxwell equation, Tds equations, Difference in heat capacities, Ratio of heat capacities, Energy equation, Joule-Kelvin effect, Clausius-Clapeyron equation, Numericals.	12
5.	**PROPERTIES OF PURE SUBSTANCES AND GASES** p-v diagram and p-T diagram for a pure substance, p-v-T surface, T-s and h-s diagram for a pure substance, Quality of pure substance, Steam tables –Saturation state, liquid-vapour mixture, compressed liquid, Charts of thermodynamic properties, Measurement of steam quality – Throttling calorimeter, Separating and throttling carlorimeter; Avogadro's law, Equation of state of gas, Ideal gas - Specific heat, internal energy and enthalpy, Entropy change, Thermodynamic property relations, work and heat transfer in reversible adiabatic, isothermal and poltropic processes of an ideal gas, Integral property relations, Viral expansions, Law of corresponding states, Generalised compressibility chart, Other equations of state, Numericals	12

TEXT BOOKS

1. **Engineering Thermodynamics**, P.K. Nag, Tata McGraw Hill Education (India) Publications, 5th Edition, 2013.

2. **A Text Book of Engineering Thermodynamics**, R.K. Rajput, Laxmi Publishers,3rd Edition, 2010.

REFERENCE BOOKS

1. **Thermodynamics:An Engineering Approach**, Yunus A. Cenegal and MichaelA. Boles, McGraw-Hill Publications (SIE), 8th Edition, 2015.

2. **Fundamentals of Thermodynamics**, Claus Borgnakke and Richard E. Sonntag,Wiley Student Edition, 7th Edition, 2009.

3. **Principles of Engineering Thermodynamics**: **S.I. Version**, Moran andShapiro, Wiley Student Edition, 2013.

e-LEARNING RESOURCES

1. **Videos and Lecture Notes:** http:// www.nptel.ac.in

DATA HAND BOOK

1. **Thermodynamics Data Book**, Richard E. Sonntag and Claus Borgnakke, Wiley Student Edition, 2nd Edition.

SYLLABUS COVERAGE FOR CIE

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)
CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**
UNIT	**1**	**2**	**3**	**4**		**5**	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.

2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit5.

3. Each question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES:

On completion of the course, student should be able to;

1. Define and describe the thermodynamic system and its properties.

2. Interpret the laws of thermodynamics with examples and illustrations.

3. Sketch and draw the property variables on various thermodynamic planes.

4. Analyze the relations governing thermodynamic properties and their applications.

5. Apply knowledge of entropy and thermodynamic relations in various thermodynamic systems.

6. Evaluate the performance of engineering systems and processes based on laws of thermodynamics.

MAPPING OF COs WITH POs

COs/POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	1	1	1
6	3	3	2	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : MECHANICS OF MATERIALS		
Course Code : ME33	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/ week : 04
Exam Duration: 3 Hrs		Exam Marks : 100
Pre-requisites	Engineering Physics, Engineering Mathematics	

Course objectives:

1. Understand mechanics of deformable bodies and apply them in analysis and design problems.
2. Analyze a body subjected to two dimensional and three dimensional stress sys-tems.
3. Examine the behavior of a structural member in flexure.
4. Evaluate the slope and deflection in beams subjected to loading.
5. Assess the stability of columns and struts.
6. Interpret the torsional behavior of structural members.

Unit No.	Syllabus	No.of hours
1.	**SIMPLE STRESS AND STRAIN** Introduction, Stress, strain, mechanical properties of materials, Linear elasticity, Hooke's Law and Poisson's ratio, Stress-Strain relation – Duc-tile & Brittle, materials. Extension / Shortening of a bar, bars with cross sections varying in steps, bars with continuously varying cross sections (circular and rectangular), Elongation due to self-weight, Principle of super position. Stress in Composite Section**:** Volumetric strain, expres-sion for volumetric strain, elastic constants, simple shear stress, shear strain, temperature stresses (including compound bars). Compound Stresses**:** Introduction, Plane stress, stresses on inclined sections, prin-cipal stresses and maximum shear stresses, Mohr's circle for plane stress.	12
2.	**BENDING MOMENT AND SHEAR FORCE IN BEAMS** Introduction, Types of beams, loads and reactions, shear forces and bending moments, rate of loading, sign conventions, relationship be-tween shear force and bending moments. Shear force and bending moment diagrams for different beams subjected to concentrated loads, uniformly distributed load, (UDL) uniformly varying load (UVL) and couple for different types of beams. Bending and Shear Stresses in Beams: Introduction, Theory of simple bending, assumptions in simple bend-ing. Bending stress equation, relationship between bending stress, ra-dius of curvature, relationship between bending moment and radius of curvature.Moment carrying capacity of standard sections. Shearing stresses in beams, shear stress across rectangular, circular, symmetrical I and T sections. (composite / notchedbeams not included).	12

3.	**ENERGY METHODS** Work, strain energy, Strain energy in bar/beams, Castiglinios theorem, Energy methods	10
4.	**DEFLECTION OF BEAMS** Introduction, Differential equation for deflection.Equations for deflec-tion, slope and bending moment.Double integration method for cantile-ver and simply supported beams for point load, UDL, UVL and Couple. Macaulay's method	08
5.	**TORSION OF CIRCULAR SHAFTS AND ELASTIC STABILITY OF 10 COLUMNS** Introduction.Pure torsion, assumptions, derivation of torsional equa-tions, polar modulus, torsional rigidity / stiffness of shafts. Power transmitted by solid and hollow circular shafts Columns**:** Euler's theory for axially loaded elastic long columns. Derivation of Euler's load for various end conditions, limitations, Rankine's formula	10

COURSE OUTCOMES:

On completion of the course, student should be able to;

1) Explain the concepts and principles applied to members under loadings, material properties.

2) Analyze structural members subjected to loads using the fundamental concepts of stress, strain and elastic behaviour of materials and thermal stresses.

3) Calculate the stresses on inclined plane by graphical method – Mohr's circle con-cept for different stress conditions

4) Develop BM & SF diagrams for cantilever & simply supported beams with differ-ent load conditions.

5) Relate bending stress, bending moment, radius of curvature, express shear stress in beams of different cross sections, and determine the deflection of beams sub-jected to different loads.

6) Analyze different machine elements such as shafts, pressure vessels for strength, rigidity and internal, external pressure respectively.

TEXT BOOKS

1. "Strength of Materials", S.S. Rattan, Tata McGraw Hill, 2009
2. "Strength of Materials", S. Ramamrutham

REFERENCE BOOKS:

1. "Mechanics of materials", James. M. Gere, Thomson, Fifth edition 2004.

2. "Mechanics of materials", in S.I. Units, Ferdinand Beer & Russell Johnstan, Tata McGraw Hill- 2003.

SCHEME OF EXAMINATION (SEE):

1. ONE FULL QUESTION from UNIT-3, UNIT-4 and UNIT-5 are COMPULSORY.
2. TWO FULL QUESTIONS each with CHOICE from UNIT-1 and UNIT-2 ONLY.
3. MAXIMUM of THREE SUB-DIVISIONS in EACH FULL QUESTION.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	1	1	1
6	3	3	2	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : MANUFACTURING PROCESS – I		
Course Code : ME34	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/ week : 04
Exam Duration: 3 Hrs		Exam Marks : 100

Course objectives:

1. This course will introduce the student to the various manufacturing processes.
2. The course will begin by examining manufacturing processes including casting and welding processes.
3. For each manufacturing process, capabilities and limitations will be discussed.

Unit No.	Syllabus	No.of hours
1.	**INTRODUCTION** Concept of Manufacturing process, its importance. Classification of Manufacturing processes. Introduction to Casting process & steps involved. Compo-nents Varieties of produced by casting processes. Advantages & Limitations of casting process. **PATTERNS**: Definition, functions, Materials used for pattern, various pattern allowances and their importance. Classification of patterns, BIS color coding of Patterns. **BINDER**: Definition, Types of binder used in moulding sand. Additives: Need, Types of additives used and their properties.	06
2.	**MOULDING PROCESSES** **SAND MOULDING:** Types of base sand, requirement of base sand. Moulding sand mixture ingredients for different sand mixtures. Method used for sand moulding, such as Green sand, dry sand and skin dried moulds. Cores: Definition, Need, Types. Method of making cores, Binders used, core sand moulding. Concept of Gating &Risers. Principle and types, Basic design of Gating and Riser with numericals. Basic steps, MouldingMachines : Jolt type, Squeeze type, Jolt & Squeeze type and Sand slinger. **SPECIAL MOULDING PROCESS:** Study of important moulding processes, No bake moulds, Flasklessmoulds, Sweep mould, CO2 mould, Shell mould, Investment mould. Metal moulds:	14
3.	**MELTING AND CASTING PROCESSES** **MELTING FURNACES -** Classification of furnaces, Constructional features & working principle of coke fired, oil fired and Gas fired pit	11

	furnace, Resistance furnace, Coreless Induction furnace, Electric Arc Furnace, Cupola furnace and process parameters affecting the furnaces. **CASTING PROCESSES -** Gravity die-casting, Pressure die casting, Centrifugal casting, Squeeze Cast-ing, Slush casting, Thixo-casting and Continuous Casting Processes. Fettlingand cleaning of castings	
4.	**WELDING PROCESSES** **INTRODUCTION:** Definition, Principles, Classification, Application, Advantages & limitations of welding. Arc Welding: Principle, Metal Arc welding (MAW), Flux Shielded Metal Arc Welding (FSMAW), Inert Gas Welding (TIG & MIG) **RESISTANCE WELDING**: Principles, Seam welding, Butt welding, Spot welding and projection welding. Friction welding, Explosive welding, Thermit welding, **RECENT WELDING PROCESSES:** Laser welding and Electron beam welding	10
5.	**METALLURGICAL ASPECTS** **DEFECTS IN CASTING AND WELDING** Casting defects, Causes, features and remedies. Structure ofwelds, Formation of different zones during welding. Heat affected zone (HAZ). Parameters affecting HAZ.Effect of carbon content on structure and properties of steel. Welding defects –Detection causes & remedy. **INSPECTION METHODS** : Methods used for Inspection of casting and welding. Visual, Magnetic particle, Fluorescent particle, Ultrasonic, Radiography, Eddy current, Holography methods of Inspection	10

COURSE OUTCOMES:

On completion of the course, student should be able to;

1) Differentiate different manufacturing processes, select a particular casting pro-cess for a given application.

2) Compare capabilities and characteristics of different sand and special moulding processes.

3) Understand the working principle and capabilities of different melting furnaces followed by understanding the special features and capabilities of different cast-ing processes.

4) Apply particular welding process to produce sound weld.

5) Analyze the causes, features and remedies of casting and welding defects

TEXT BOOKS

1. "Manufacturing Process-I & II", Dr. K. Radhakrishna, Sapna Book House, 5th Revised Edition 2009.

1. "Manufacturing & Technology: Foundry Forming and Welding", P.N. Rao 2nd Ed., TMH, 2003.

2. Manufacturing Science, AmitabhaGhoshandMallik, affiliated East West Press,2003.

3. Metal Casting: Principles and Practice, T.V. RamanaRao,Published by NewAge International (P) Limited (2010)

4. Principles of Metal Casting, MahiSahoo **,** Sam Sahu **, McGraw Hill Educa-tion (India) Private Limited; Third edition (26 September 2014)**

REFERENCE BOOKS:

1. "Manufacturing Technology", SeropeKalpakjain, Steuen.R. Sechmid, Pearson Education Asia, 5th Ed. 2006.

2. "Process and Materials of Manufacturing", Roy A Lindberg, 4th Ed. PearsonEdu. 2006.

3. Principles Of Metal Casting- Second Edition, Heine, Richard W.; CarlR. Loper, Jr. & Philip C. Rosenthal, Published by McGraw-Hill, New York (1967)

4. Mechanical Metallurgy Paperback , George E. Dieter**TMH**

SCHEME OF EXAMINATION (SEE):

1. ONE FULL QUESTION from UNIT-1, UNIT-4 and UNIT-5 are COMPULSORY.

2. TWO FULL QUESTIONS with CHOICE from UNIT-2 and UNIT-3 ONLY.

3. MAXIMUM of THREE SUB-DIVISIONS in EACH FULL QUESTION.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	1	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : METROLOGY AND MEASUREMENTS		
Course Code : ME35	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/ week : 03
Exam Duration: 3 Hrs		Exam Marks : 100

Course objectives:

1. Explain the concepts of measurement and gauging instruments.
2. Appreciate the relevance with regards to practical applications.
3. Explain and apply the principles in manufacturing industries.

Unit No.	Syllabus	No.of hours
1.	**STANDARDS OF MEASUREMENT** Definition and Objectives of metrology, Standards of length-International prototype meter, Imperial standard yard, Wave length standard, subdivision of standards, line and end standard, calibration of end bars (Numerical), Slip gauges, Wringing phenomena, Indian Standards (M-81, M-12), Numerical problems on building of slip gauges. System of Limits, Fits, Tolerance and Gauging**:** Definition of tolerance, Specification in assembly, Principle of inter-changeability and selective assembly limits of size, Indian standards, concept of limits of size and tolerances, compound tolerances, accumulation of tolerances, definition of fits, types of fits and their designation (IS919-1963), geometrical tolerance, positional-tolerances, hole basis system, shaft basis system.	08
2.	**CLASSIFICATION OF GAUGES** Brief concept of design of gauges (Taylor's principles), Wear allowance on gauges, Types of gauges-plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials. Comparators and Angular measurement: Introduction to comparators, characteristics, classification of comparators, mechanical comparators-Johnson Mikrokator, sigma comparators, dial indicator, optical comparators-principles, Zeiss ultra optimeter, electric and electronic comparators-principles, LVDT, pneumatic comparators, back pressure gauges, solex comparators. Angular measurements, bevel protractor, sine principle and use of sine bars, sine centre, use of angle gauges (numericals on building of angles), clinometers. **MEASUREMENT OF SURFACE ROUGHNESS** Parameters of 2D and 3D surface parameters.Measurement of form- Straightness, flatness, perpendicularity, parallelism, roundness and cylindricals	10

3.	**INTERFEROMETER, SCREW THREAD AND GEAR MEASUREMENT** Interferometer, interferometry, auto collimator. Optical flats. Terminology of screw threads, measurement of major& minor diameters, pitch, angle and effective diameter of screw threads by 2& 3-wire methods, best size wire. Tool maker's microscope, gear tooth, terminology, use of gear tooth vernier cali-per and micrometer. Measurements and measurement systems**:** Definition, significance of measurement, generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hysterisis, repeatability, linearity, loading effect, system response-times delay. Errors in measurement, classification of errors.Transducers, transfer efficiency, primary and secondary transducers, electrical, mechanical, electronic transducers, advantages of each type of transducers.	10
4.	**INTERMEDIATE MODIFYING AND TERMINATING DEVICES** Mechanical systems, electronic amplifiers and telemetry. Terminating devices, mechanical, cathode ray oscilloscope, oscillographs, X-Y plotters. **MEASUREMENT OF FORCE, TORQUE AND PRESSURE** Principle, dynamometer, proving ring.Torque measurement.	06
5.	**PRESSURE MEASUREMENTS** Principle, use of elastic members, Bridgeman gauge, McLeod gauge, Piranigauge. Temperature and strain measurement: Resistance thermometers, Thermocouple, Law of thermocouple, Materials used for construction, Pyrometer, Optical pyrometer. Strain measurements, preparation and mounting, gauge factor, methods of strain measurement, Co-ordinate Measuring Machine (CMM) Principle of operation, working and applications.	05

COURSE OUTCOMES:

On completion of the course, student should be able to;

1) Describe different standards and the importance of standardization.

2) Recognize measurements necessity, various dimensional measurements.

3) Design measurement system for a given parameter

4) List the different kinds of sensors, transducers, and recorders.

5) Assess measurement system with its limitations.

TEXT BOOKS:

1. Mechanical Measurements, Beckwith Marangoni and Lienhard, PearsonEducation, 6^{th} Edition, 2006. (For Measurements Only)

2. Engineering Metrology, R.K. Jain, Khanna Publishers, 1994. (For Metrology Only)

REFERENCE BOOKS:

1. **Engineering Metrology,** I.C. Gupta, DhanpatRai Publications, Delhi.
2. **Mechanical Measurements,** R.K. Jain
3. **Industrial Instrumentation,** Alsutko, Jerry. D. Faulk, Thompson Asia Pvt. Ltd.2002.
4. **Measurement Systems Applications and Design,** Ernest O. Doblin, McGraw Hill

SCHEME OF EXAMINATION (SEE):

1. ONE FULL QUESTION from UNIT-1, UNIT-4 and UNIT-5 are COMPULSORY.
2. UNIT -2 and UNIT-3 WILL HAVE INTERNAL CHOICE ONLY.
3. MAXIMUM of THREE SUB-DIVISIONS in EACH FULL QUESTION

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	1	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : COMPUTER AIDED MACHINE DRAWING		
Course Code : MEL36	No of Credits : L-T-P-SS 02:00:04:00 =04	No. of lecture hours/ week : 06
Exam Duration: 3 Hrs		Exam Marks : 50

Course objectives:

1. To understand the sectional views and thus developments of various solid shapes
2. Simple machine parts orthographic views with and without sections to be under-stood
3. Different types of thread forms to be studied
4. Permanent and temporary fasteners study
5. Assembly drawings in 2D of several joints and couplings

Unit No.	Syllabus	No.of hours
1.	**SECTIONS OF SOLIDS** Prisms, pyramids, cones, cylinders cut by a single section plane perpendicular to Vertical Plane and inclined to Horizontal Plane **ORTHOGRAPHIC PROJECTIONS** Orthographic views of simple machine parts with and without sections	**16**
2.	**RIVETED JOINT** Single riveted lap joints, double riveted lap joints, with chain and zig-zag type, Single riveted butt joints with single and double cover plates, Double riveted butt joints with single and double cover plates with chain and zig-zag riveting **2D ASSEMBLY DRAWINGS -COUPLINGS** Split muff, protected type flange, Oldham's coupling	**16**
3.	**ASSEMBLY** Screw jack (Bottle type), Plummer block (Pedestal Bearing) and Machine vice	**46**

COURSE OUTCOMES:

On completion of the course, student should be able to;

1. Viewing a section with a specific orientation to understand interior details.
2. Identifying several thread forms and pinpointing their usage
3. Realise Fasteners and their importance with specific decision to select the right type of fastener for the right job
4. Make Assembly of various parts of joints and couplings

TEXT BOOKS:

1. **Computer Aided Machine Drawing-2007'**, Published by VTU, Belgaum.

REFERENCE BOOKS:

1. Machine Drawing', K.R. Gopala Krishna, Subhash Publication.

2. Machine Drawing', N. D. Bhat& V. M. Panchal

3. Computer Aided Machine Drawing', S. Trymbaka Murthy, CBS Publishers, New Delhi, 2007.

CONTINUOUS INTERNAL EVALUATION (CIE)

1. CIE has a maximum of 50 marks.

2. All the sheets should be drawn in the class using Solid edge software. Sheet sizes should be A4. All sheets must be submitted at the end of the class by taking printouts.

3. CIE Marks is finalized by conducting a test at the end of 10^{th} week of the semes-ter.

4. CIE Marks (50) = Evaluation of Record (Sketch-15 and Printout-15) + Test (20)

SCHEME OF EXAMINATION (SEE):

1. Total number of full questions to be set: 06.
2. Two question to be set from each unit compulsorily
3. Student has to answer one question from each unit

UNIT -1	=	**10 MARKS**
UNIT-2	=	**10 MARKS**
UNIT-3	=	**30 MARKS**
TOTAL		**50 MARKS**

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : MANUFACTURING PROCESS LABORATORY- I		
Course Code : MEL37	No of Credits : L-T-P-SS 00:00:02:00 =01	No. of lecture hours/ week : 02
Exam Duration: 3 Hrs		Exam Marks : 50

Course objectives:

1. This course will give the student knowledge of testing sand used in foundries.
2. It also focuses on preparation of sand moulds, forging a component.

Unit No.	Syllabus	No.of hours
1.	**TESTING OF MOLDING SAND AND CORE SAND** Preparation of sand specimens and conduction of the following tests: 1. Compression, Shear and Tensile tests on Universal Sand Testing Machine. 2. Permeability test 3. Core hardness &Mould hardness tests. 4. Sieve Analysis to find Grain Fineness number of Base Sand 5. Clay content determination in Base Sand	08
2.	**FOUNDRY PRACTICE** ¬Use of foundry tools and other equipments. ¬Preparation of moulds using two moulding boxes using pat-terns or without patterns. (Split pattern, Match plate pattern and Core boxes). ¬Preparation of one casting (Aluminum or cast iron-Demon-stration only)	09
3.	**FORGING OPERATIONS** ¬ Calculation of length of the raw material required to do the model. ¬ Preparing minimum three forged models involving upsetting, drawing and bending operations. Out of these three models, at least one model is to be prepared by using Power Hammer	09

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Test and analyze the properties of sand used in foundries as per international standards.
2. Develop a mould for simple applications.
3. Fabricate a simple forging components using different tools .

CONTINUOUS INTERNAL EVALUATION (CIE)

1. CIE has a maximum of 50 marks.
2. CIE Marks is finalized by conducting a test at the end of 10^{th} week of the semes-ter.
3. CIE Marks (50) = Evaluation of Record (30) + Test (20)

REFERENCE BOOKS:

1. **"Manufacturing & Technology**: Foundry Forming and Welding", P.N. Rao 2nd Ed., Tata McGraw Hill, 2003.

2. **Manufacturing Science, AmitabhaGhosh and Mallik,** affiliated East West Press,2003.

3. **Metal Casting: Principles and Practice**, T.V. RamanaRao,Published by NewAge International (P) Limited (2010)

4. **Principles of Metal Casting,** MahiSahoo **,** Sam Sahu **, McGraw Hill Educa-tion (India) Private Limited; Third edition (26 September 2014)**

SCHEME OF EXAMINATION (SEE):

One Compulsory Model from UNIT -1	15 MARKS
One optional Model from UNIT - 2	25 MARKS
One optional Model from UNIT - 3	25 MARKS
Viva – Voce	10 MARKS
TOTAL	**50 MARKS**

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1		1	2	1	1
2	3	3	2	1	1	1	1		1	1	1	1
3	3	3	3	1	2	1	1		1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : METROLOGY AND MEASUREMENTS LABORATORY		
Course Code : MEL38	No of Credits : L-T-P-SS 00:00:02:00 =01	No. of lecture hours/ week : 02
Exam Duration: 3 Hrs		Exam Marks : 50

Course objectives:

1. Calibration of vital tools including micrometer in measurements laboratory

2. Calculate modulus of elasticity of a ductile specimen

3. Measurement of parameters like; Angle, Alignment, Cutting tool forces, Screw thread, Surface roughness and Gear tooth profile

Unit No.	Syllabus	No.of hours
1.	**MEASUREMENTS** 1. Calibration of Pressure Gauge 2. Calibration of Thermocouple 3. Calibration of LVDT 4. Calibration of Load cell 5. Determination of modulus of elasticity of a ductile specimen using strain gauges	**12**
2.	**METROLOGY** 1. Measurements using Optical Projector / Toolmaker Microscope. 2. Measurement of angle using Sine Center / Sine bar / bevel protractor 3. Measurement of alignment using Autocollimator / Roller set 4. Measurement of cutting tool forces using-Lathe tool & Drill tool Dynamometer. 5. Measurement of Screw threads Parameters using Two wire or Three-wire method. 6. Measurements of Surface roughness, Using Tally Surf/Me-chanicaL Comparator 7. Measurement of gear tooth profile using gear tooth vernier /Gear tooth micrometer 8. Calibration of Micrometer using slip gauges 9. Measurement using Optical Flats	**09**

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Vital tools calibration methods are understood in the metrology section

2. To the measurements section several important parameters are measured using several versatile equipments.

REFERENCE BOOKS:

1. Mechanical Measurements, Beckwith Marangoni and Lienhard, PearsonEducation, 6th Edition, 2006. (For Measurements Part Only)

2. Engineering Metrology, R.K. Jain, Khanna Publishers, 1994

3. Mechanical Measurements and Metrology', Dr. T. Chandrashekar, SubhashStores, 3rd Edition, 2009.

CONTINUOUS INTERNAL EVALUATION (CIE)

1. CIE has a maximum of 50 marks.
2. CIE Marks is finalized by conducting a test at the end of 10th week of the semes-ter.
3. CIE Marks (50) = Evaluation of Record (30) + Test (20)

SCHEME OF EXAMINATION (SEE):

ONE question from PART A	15 MARKS
ONE question from PART B	25 MARKS
Viva –Voce	10 MARKS
TOTAL	**50 MARKS**

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : BASIC ENGINEERING MATHEMATICS - I		
Course Code : MADIP31	No of Credits : 00	No. of lecture hours/ week : 04
Exam Duration: 3 Hrs		Exam Marks : 50

Course Objective: To develop a basic Mathematical knowledge required for higher semesters with few examples of its engineering applications.

Unit No.	Syllabus	No.of hours
1.	**Differential Calculus:** Polar curves, angle between polar curves and condition fororthogonality. Pedal equation for polar curves, Radius of curvature–in Cartesian,parametric, polar and pedal forms (with proof)-problems. Taylor's and Maclaurin's expansions.	10
2.	**Partial Differentiation:** Partial derivatives, Homogeneous functions, Euler's theorem(with proof and no extended theorem). Total differential and differentiability, Derivativesof composite and implicit functions, change of variables.	10
3.	**Integral Calculus:** Reduction formulae for $\int \sin^n x dx$, $\int \cos^n x dx$, $\int \sin^m x \cos^n x\, dx$ Evaluation of the integrals using reduction formula with standard limits-Problems. Tracing of curves in Cartesian and Polar forms (Cissoid, Astroid, Cardioid and Lemniscate).	10
4.	**Multiple Integrals:** Double integrals in Cartesian and polar coordinates, Change of order of integration, Area enclosed by plane curves, Change of variables in double integrals, Area of a curved surface. Triple integrals-Volume of solids.	10
5.	**Differential Equations:** Solution of homogeneous, Linear and Exact differential equations and its reductions. Solutions of Linear differential equations of higher order with constant coefficients-inverse differential operator.	10

Course Outcomes: After the successful completion of the course, the students are able to

CO1: analyzethe basic concepts of calculus like differentiation and integration

CO2: apply the concepts of partial differentiation and differential equations arising in a variety of engineering applications

CO3: assess the practical importance of polar curves, Jacobians and radius of curvature

CO4: apply the concepts in problem solving and relate the solutions to the various engineering streams

CO5: use the skills in understanding Mathematical knowledge

Course Outcomes (CO) Mapping with Programme Outcomes (PO)

CO1: PO1, PO2
CO2: PO1, PO2
CO3: PO1, PO2
CO4: PO1
CO5: PO1

TEXT BOOKS:

1. B.S. Grewal, Higher Engineering Mathematics (Latest Edition, 2016), Khanna Publishers, New Delhi.

2. Erwin Kreyszig, Advanced Engineering Mathematics (10th Edition, 2016), Wiley Publishers, New Delhi.

REFERENCE BOOKS:

1. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill publications, New Delhi.

2. Peter V. O'Neil, Advanced Engineering Mathematics (7thEdition), Cengage Learning, Publishers U.S.A.

3. H.K.Dass and Er. RajnishVerma, Advanced Engineering Mathematics (Latest Edition 2015),S.Chand Publisher, New Delhi.

COURSE TITLE : ENGINEERING MATHEMATICS-IV		
Course Code : MA41	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/ week : 04 (L=4)
Exam Duration: 3 Hrs	Exam Marks: CIE + Assignment + SEE = 45 + 5 + 50 = 100	Exam Marks : 50

Course objectives:

To introduce applied concepts in mathematics which will be beneficial to students of all engineering courses.

Unit No.	Syllabus	No.of hours
1.	**Functions of a Complex Variable:** Review of continuity, differentiability. Definition-analytic function, Cauchy-Riemann equations in Cartesian and polar forms. Harmonic and orthogonal properties of analytic function. Construction of analytic functions, Conformal Transformations, Discussion of transformations:	10
2.	**Complex Integration:** Complex line integrals, Cauchy's theorem and Cauchy's integral formula. Taylor's and Laurent's series (without proof), Singularities, poles and residues, Residue theorem (without proof). Applications- Contour integrals of the forms : $\int_0^{2\pi} f(\sin\theta, \cos\theta)\,d\theta$ and $\int_{-\infty}^{\infty} f(x)\,dx$	10
3.	**Mathematical Modeling**: Basic concepts. Real world problems, Approximation of the problem, Steps involved in modeling. Mathematical models: Linear growth and decay model, Logistic model, model of Mass-spring-dashpot, Chemical reaction, Drug absorption from blood stream. Motion of a projectile. Applications-Current flow in electrical circuits (LRC), Model for detection of diabetes.	10
4.	**Joint Probability Distributions and Markov Chains:** Introduction, Joint probability and Joint distribution of discrete random variables, Markov chains, Classification of Stochastic processes, Probability Vector, Stochastic Matrix, Regular Stochastic Matrix, Transition Probabilities and Transition probability Matrix, Higher Transition Probabilities, Stationary distribution of regular Markov chains, States of a Markov chain.	10
5.	**Statistical Techniques:** Review of measures of central tendency and dispersion, Curve fitting by method of least squares-fitting of $y = ax + b,\ y = ax^2 + bx + c,\ y = a\,e^{bx}$ and $y = ab^x$	10

	Correlation-Karl Pearson's coefficient of correlation-problems. Regressionanalysis- lines of regression (without proof).	

Course Outcomes:

After the successful completion of the course, the students are able to

CO1: analyze the basic concepts of complex variables, analyticity and integrals of complex valued functions and statistical methods.

CO2: construct complex functions like potential functions, stream lines and stream functions required in engineering fields related to Fluid Mechanics, Thermodynamics and Electromagneticfields.

CO3: create a model for different aspects of real-world engineering problems.

CO4: assess how to translatethe functions of one complex plane to the other

CO5: implement a variety of statistical techniques to solve problems of engineering fields like, industry standard statistical software, air and ground water pollution.

Course Outcomes (CO) Mapping with Programme Outcomes (PO)

CO1: PO1, PO2
CO2: PO1, PO2
CO3: PO1, PO2
CO4: PO1, PO2
CO5: PO1, PO2

TEXT BOOKS

1. B.S. Grewal, Higher Engineering Mathematics (Latest Edition, 2016), Khanna Publishers, New Delhi.

2. Erwin Kreyszig, Advanced Engineering Mathematics (10th Edition, 2016), Wiley Publishers, New Delhi.

3. J. N. Kapur : Mathematical Modeling, Wiley Eastern Ltd., 1998.

REFERENCE BOOKS

1. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill publications, New Delhi.

2. Peter V. O'Neil, Advanced Engineering Mathematics (7thEdition), Cengage Learning, Publishers U.S.A.

3. H.K.Dass and Er. RajnishVerma, Advanced Engineering Mathematics (Latest Edition 2015),S.Chand Publisher, New Delhi.

4. Dennis G Zill, Mihael,Gulle, Advanced Engineering Mathematics (2ndEdn), CBS publishers.

5. Andrei D. Polyanin and Alexander V. Manzhirov, Chapman & Hall/CRC, Taylor & Francis Group, New York.

6. Edsberg, L., "Introduction to Computation and Modeling for Differential Equations", John Wiley and Sons.

QUESTION PAPER PATTERN:

The Semester End Examination (SEE) is for 100 marks.

1. There shall be five full questions (one question for each unit) carrying 20 marks each and all are compulsory

2. There shall be internal choice in Unit 2 and Unit 3

Note: Two Assignments are evaluated for 5 marks: Assignment – I from Units 1 and 2. Assignment – IIfrom Units 3,4 and 5.

COURSE TITLE : TURBO MACHINES		
Course Code : ME41	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/ week : 04
Exam Duration: 3 Hrs		Exam Marks : 100
Pre-requisites	Engineering Physics, Engineering Mathematics	

Course objectives:

1. To outline the working principle of turbo machines with examples. Classifies turbo ma-chines and describes the energy transfer mechanism of turbo machines

2. To explain the functioning of radial flow and axial flow turbo machines such as centrifugal pumps, compressors, steam, gas and hydraulic turbines

3. To demonstrate the effect of important variables affecting the output of turbo machines.

4. To sketch the velocity diagrams for various types of turbo machines

5. To analyze a given problem and apply the fundamental knowledge to solve the problem

6. To estimate and evaluate unknown parameters and predict the performance of turbo machines

Unit No.	Syllabus	No.of hours
1.	**Introduction And General Analysis Of Turbo Machines** Definition of a turbo machine; parts of a turbo machine; comparison with positive displacement machine; classification; Energy transfer in a turbomachine - Euler turbine equation; alternate form of Euler turbine equation (components of energy transfer); degree of reaction, utilization factor and relationship between them; Maximum utilization factor; General analysis of radial flow turbomachines (turbines and pumps) - Effect of blade discharge angle on their performance; Theoretical head-capacity relationship; Related numericals.	10
2.	**GENERAL ANALYSIS OF AXIAL FLOW TURBO MACHINES** General analysis of axial flow turbines – utilization factor, degree of reaction, relationship between utilization factor and blade speed ratio; Maximum utilization factor and optimum blade speed ratio for impulse and reaction axial flow turbines; General analysis of axial flow compressors and pumps – general expression for energy transfer and degree of reaction; Related numericals	08
3.	**STEAM TURBINES** Introduction; Different efficiencies; Analysis of single stage impulse (De Laval) turbine; Impulse staging and need for compounding; Analysis of velocity compounded impulse (Curtis) turbine; Analysis of Impulse-reaction (Rateau) turbine; Reheat factor for multi stage turbine; Related numericals.	10
4.	**HYDRAULIC TURBINES** Introduction; Classification; Different heads and efficiencies; Pelton turbine-velocity triangles; Francis turbine-velocity triangles, runner shapes for different blade speeds; function of a draft tube, types of draft tube; Kaplan and Propeller turbines – velocity triangles and analysis; Related numerical problems; Specific speed and its significance; Unit quantities and their uses; Characteristic curves of hydraulic turbines.	12
5.	**CENTRIFUGAL PUMPS AND COMPRESSORS** Centrifugal pumps –Introduction, Main parts of a centrifugal pump; Work done; Definitions of heads and efficiencies; mini-mum speed for starting; Multistage centrifugal pump; Specific speed; Priming; Characteristic curves; Cavitation; Thoma's cavi-tation factor; Maximum suction lift; Net positive suction head; Related numerical problems: Centrifugal compressors-Intro-duction; Work done; Overall pressure ratio developed; Pressure ratio in terms of φ_s ,φ_p ,φ_w ; Compressibility and pre-whirl; Dif-fuser design; Surging; Related numericals	12

TEXT BOOKS

1. **Turbo Machines**, Dr. N. Krishnamurthy, Sunstar Publisher, 2nd Edition, 2015.

2. **Turbomachines**, B.U. Pai, Wiley Precise Textbook Series, 2014.

3. **A Textbook of Fluid Mechanics and Hydraulic Machines (SI Units)**, Dr.R.K. Bansal, Laxmi Publications (P) Limited, Revised 9th Edition, 2010.

REFERENCE BOOKS

1. **An introduction to energy conversion, Vol. III – Turbomachinery**, V.Kadambi and Manohar Prasad, 2nd Edition, New Age International Publishers (P) Limited, 2011.

2. **Principles of turbomachinery**, D. G. Shepherd, MacMillan Company, 1964.

SYLLABUS COVERAGE FOR CIE

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)
CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respec-tively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit5.
3. Each question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES:

On completion of the course, student should be able to;After the completion of the course, students will be able to:
1. Describe the general working of turbo machines
2. Illustrate the functioning of radial flow and axial flow turbo machines with ex-amples.
3. Sketch and draw the velocity diagrams for turbo machines.
4. Classify and analyze the various types of turbo machines.
5. Derive various equations related to the performance of turbo machines
6. Evaluate and compute the performance of various turbo machines.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	2	1	2	1	1	1	1	1	1	1
2	3	3	3	1	2	1	1	1	1	2	1	1
3	3	3	2	1	1	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	2	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	1	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : APPLIED THERMODYNAMICS		
Course Code : ME42	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/ week : 04
Exam Duration: 3 Hrs		Exam Marks : 100
Pre-requisites	Engineering Physics, Engineering Mathematics	

Course objectives:

1. To relate the fundamentals of thermodynamics to the real time applications.
2. To describe the various thermodynamic power cycles which use air and vapour as the working fluid
3. To apply the fundamental concepts to derive various thermodynamic variables for solving numerical problems
4. To design and develop various thermodynamic systems and predict their performance

Unit No.	Syllabus	No.of hours
1.	**AIR STANDARD POWER CYCLES** Introduction; Air Standard cycles-Description of various processes, p-v and T-s diagrams, derivation of efficiency and mean effective pressure of Carnot, Otto, Diesel and Dual combustion cycles; Comparison of Otto, Diesel and Dual combustion cycles in terms of same compression ratio, same heat input and maximum cycle pressure; Related numericals	08
2.	**RECIPROCATING COMPRESSORS** Introduction; Working principle, p-v diagram and derivation of work input of a single stage reciprocating compressor; Adiabatic, isothermal and mechanical efficiencies; Effect of clearance and derivation of volumetric efficiency; Multistage compressor; Saving in work, optimum intermediate pressure, inter-cooling, minimum work for compression; Related numericals	10
3.	**VAPOUR POWER CYCLES** Introduction; Performance parameters; Carnot vapour power cycle; Rankine Cycle; Influence of thermodynamic variables in Rankine cycle; Actual vapour power cycle; Comparison of Rankine and Carnot cycles; Mean temperature of heat addition; Reheat cycle; Ideal and practical regenerative cycle; Reheat-regenerative cycle; Feedwater heaters; Binary vapour power cycles; Numerical problems on Carnot cycle, Rankine cycle, Reheat cycle and Regenerative cycle.	10
4.	**REFRIGERATION CYCLES** Introduction; Units of refrigeration; COP; Reversed heat engine cycle; Vapour compression refrigeration cycle; Performance and capacity of a	12

	vapour compression plant; Actual vapour compression cycle; Effect of change in operating conditions on the performance of vapour compression cycle; Components in a vapour compression plant; Multi-stage vapour compression systems; Multi-evaporator systems; Cascade systems; Refrigerants; Selection of a refrigerant; Absorption refrigeration system and theoretical COP; Electrolux refrigerator; Steam jet refrigeration system; Gas cycle refrigeration; Polytropic and multistage compression; Application to aircraft refrigeration; Bootstrap system; Numerical problems on reversed heat engine cycle, vapour compression cycle and aircraft refrigeration cycle.	
5.	**GAS TURBINE PLANTS AND JET PROPULSION SYSTEM** Introduction; Classification and comparison; Application of gas turbines; Advantages and disadvantages of gas turbine plants; Analysis of simple constant pressure gas turbine cycle (Brayton cycle); Methods to improve the performance of gas turbine plant – Regenerative and reheat gas turbine cycle; Gas turbine cycle with intercooling; Gas turbine cycle with reheat and regeneration; Gas turbine with reheat and intercooling; Gas turbine with regeneration, reheat and intercooling; Gas turbine irreversibilities and losses; Compressor and turbine efficiency; Gas turbine cycles for jet propulsion, Thrust, Propulsive power and propulsive efficiency; Classification of gas turbine engines, Comparison of various propulsion devices; Numericals	**12**

TEXT BOOKS

1. **Basic and Applied Thermodynamics,** P.K. Nag, Tata McGraw-Hill Publica-tions, 2nd Edition, 2010.

2. **Applied Thermodynamics,** Omkar Singh, New Age International (P) Limited,2003.

3. **Gas Turbines and Jet Rocket Propulsion**, V.M. Domkundwar, DhanpatRai&Co. (P) Limited, 2nd Edition, 2013.

REFERENCE BOOKS

1. **A Course in Thermal Engineering,** A. Domkundwar, C.P. Kothandaraman, S.Domkundwar, DanpatRai and Co (P) Limited, 2013.

e-LEARNING RESOURCES

1. **Videos and Lecture notes:** http:// www.nptel.ac.in

DATA HAND BOOKS AND CHARTS

1. **Steam Tables with Mollier Diagram: SI Units**, Mahesh M. Rathore, DhanpatRai Publishing Company, 2014.

2. **Refrigeration Tables and Charts: SI Units,** C.P. Kothandaraman**,** 4th Edition,New Age International Publishers, 2015.

SYLLABUS COVERAGE FOR CIE

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)
CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	**1**	**2**	**3**	**4**		**5**	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.

2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit5.

3. Each question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES:

On completion of the course, student should be able to;After the completion of the course, students will be able to:

1. Identify and describe thermodynamic power cycles and refrigeration cycles.
2. Explain the various thermodynamic cycles giving examples and illustrations.
3. Sketch and draw thermodynamic cycles to solve for various parameters by applying the basic principles of thermodynamics.
4. Compare and analyse different types of thermodynamic cycles.
5. Derive various expressions to measure the performance of thermodynamic power cycles and refrigeration cycles.
6. Calculate and compute the performance of various thermal engineering systems.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	2	1	2	1	1	1	1	2	1	1
2	3	3	3	1	2	1	1	1	1	1	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	2	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : KINEMATICS OF MACHINES		
Course Code : ME43	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/ week : 04
Exam Duration: 3 Hrs		Exam Marks : 100
Pre-requisites	Engineering Physics, Engineering Mathematics	

Course objectives:

1) Explain the types of relative motion.
2) Differentiate between Machine, Mechanism, and Structure.
3) Draw the velocity and acceleration diagram of various linkages.
4) Determine the gear parameters and check for interference.
5) Calculate the fixing torque in gear trains.
6) Design the Cam profile for the desired follower motion.

Unit No.	Syllabus	No.of hours
1.	**INTRODUCTION** Definitions Link or element, kinematic pairs, Degrees of freedom, Grubler's criterion (without derivation), Kinematic chain, Mechanism, Structure, Mobility of Mechanism, Inversion, Machine. **KINEMATIC CHAINS AND INVERSIONS** Inversions of Four bar chain; Single slider crank chain and Double slider crank chain. Practical applications. **MECHANISMS** Quick return motion mechanisms-Drag link mechanism, Whitworth mechanism and Crank and slotted lever Mechanism. Straight line motion mechanisms Peaucellier's mechanism and Robert's mechanism. Intermittent Motion mechanisms -Geneva wheel mechanism and Ratchet and Pawl mechanism. Toggle mechanism, Pantograph, Ackerman steering gear mechanism.All wheel drive mechanism.	10
2.	**Velocity And Acceleration Analysis Of Mechanisms (GRAPHICAL METHODS)** Velocity and acceleration analysis of Four Bar mechanism, Slider crank mechanism and Simple Mechanisms by vector polygons: Relative velocity and acceleration of particles .in a common link, relative velocity and accelerations of coincident Particles on separate links- Coriolis component of acceleration. Angular velocity and angular acceleration of links, velocity of rubbing.	10
3.	**VELOCITY ANALYSIS BY INSTANTANEOUS CENTER METHOD** Definition, Kennedy's Theorem, Determination of linear and angular velocity using instantaneous center method **KLEIN'S CONSTRUCTION**: Analysis of velocity and acceleration of single slider crank mechanism	10
4.	**GEARS** Spur gears and its terminology, law of gearing, Characteristics of involute action, Path of contact, Arc of contact, Contact ratio of spur, helical, bevel and worm gears, Interference in involute gears. Methods of avoiding interference, Backlash, Comparison of involute and cycloidal teeth. **GEAR TRAINS:** Simple gear trains, Compound gear trains for large speed reduction, Epicyclic gear trains, Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains. Tooth load and torque calculations in epicyclic gear trains.	12
5.	**CAMS** Types of cam, Types of follower. Displacement, Velocity and, Acceleration time curves for cam profiles. Disc cam with reciprocating follower having knife-edge, roller and flat-face follower, Disc cam with oscillating roller follower. Follower motions including SHM, Uniform velocity, uniform acceleration and retardation and Cycloidal motion	12

COURSE OUTCOMES: On completion of the course, student should be able to;

1) Identify the types of Kinematic motion in machines used in everyday life.

2) Calculate the velocity and acceleration of linkages using graphical, analytical, and vector approaches.

3) Synthesize mechanisms for prescribed path and motion generation using graphical, analytical, and computational methods.

4) Design the cam profile for the desired follower motion for applications such as IC engine valves, machine tools.

5) Estimate the gear tooth parameters and train value for different types of gear trains.

TEXT BOOKS

1. **"Theory of Machines",** Thomas Bevan

2. **"Theory of Machines",** Rattan S.S, Tata McGraw-Hill Publishing Company Ltd., NewDelhi, and 3rd edition -2009.

3. **"Theory of Machines",** Sadhu Singh, Pearson Education (Singapore) Pvt. Ltd, In-dian Branch New Delhi, 2nd Edi. 2006

REFERENCE BOOKS

1. **"Theory of Machines & Mechanisms"**, J.J. Uicker, G.R. Pennock, J.E. Shigley. OXFORD 3rd Ed. 2009.

2. **Mechanism and Machine theory**, Ambakar, PHI

Graphical Solutions may be obtained either on the Graph Sheets or on the Answer Book itself.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

(irrespective of portions covered due to whatever might be the reason)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	1	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : MANUFACTURING PROCESS – II		
Course Code : ME44	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/ week : 04
Exam Duration: 3 Hrs		Exam Marks : 100

Course objectives:

1. To expose the students to a variety of manufacturing processes including their typical use and Capabilities.

2. To teach the students mechanical aspects of manufacturing processes, such as cutting force, tool life.

3. To provide students a technical understanding of common traditional processes and non-traditional processes to aid in appropriate process selection for the ma-terial and required tolerances.

Unit No.	Syllabus	No.of hours
1.	**INTRODUCTION** **THEORY OF METAL CUTTING** Single point cutting tool nomenclature, geometry. Mechanics of Chip Formation, Types of Chips. Merchants circle diagram and analysis, Ernst Merchant's solution, shear angle relationship, problems on Merchant's analysis. Tool Wear and Tool failure, tool life. Effects of cutting parameters on tool life. Tool Failure Criteria, Taylor's Tool Life equation. Problems on tool life evaluation. **CUTTING TOOL MATERIALS:** Desired properties and types of cutting tool materials – HSS, carbides, coated carbides, ceramics. Cutting fluids. Desired properties, types and selection. Heat generation in metal cutting, factors affecting heat generation. Heat distribution in tool and work piece and chip. Measurement of tool tip temperature.	**10**
2.	**BASIC MACHINE TOOLS** **TURNING (LATHE), SHAPING AND PLANING MACHINES** Classification, constructional features of Turret and Capstan Lathe. Tool Layout, Shaping Machine, Planing Machine, Driving mecha-nisms of lathe, shaping and Planing machines, Different opera-tions on lathe, shaping machine and Planing machine. Simple problems on machining time calculations. **DRILLING AND MILLING MACHINES** Classification, constructional features, drilling & related operations. Types of drill & drill bit nomenclature, drill materials, milling cutters nomenclature, milling operations, up milling and down milling concepts. Various milling operations. Indexing: Simple, compound, differential and angular indexing calculations. Simple problems on simple and compound indexing.	**14**

3.	**GRINDING AND FINISHING PROCESSES** **GRINDING :** Types of abrasives, Grain size, bonding process, grade and structure of grinding wheels, grinding wheel types. Classification, constructional features of grinding machines (Centerless, cylindrical and surface grinding). Selection of grinding wheel. Grinding process parameters. Dressing and truing of grinding wheels. **BROACHING-**Principle of broaching. Details of a broach. Types of broaching machines-constructi onal details. Applications. Advantages and Limi-tations. **FINISHING PROCESSES:** Lapping and Honing operations – Principles, arrangement of set up and application. **SUPER FINISHING PROCESS:** Polishing, buffing operation anD application	14
4.	**FORGING** Classification of forging processes, forging machines and equipments. Expressions for forging pressures and load in open die forging and closed die forging by slab analysis, concept of friction hill and factors affecting it. Die-design parameters. Material flow lines in forging. Forging defects, Residual stresses in forging. Simple problems.	08
5.	**NON-TRADITIONAL MACHINING PROCESSES** Classification, Mechanism of material removal, Principle of work-ing, process parameters, process capabilities, application and limi-tations of ECM, EDM, WEDM and USM.	06

COURSE OUTCOMES: On completion of the course, student should be able to;

1) Understand and analyze the effect of temperature, strain rate in metal working, heat affected zones and learn different tool materials.

2) Describe the different machining operations performed on lathe, shaping, plan-ning, milling and drilling along with their features.

3) Differentiate finishing processes, know their capabilities and applications

4) Select different forging processes, machines, knowledge of die design param-eters,. Analyze and calculate the forging pressure and load in open die forging and identify forging defects.

5) Differentiate different non-traditional machining processes based on the mecha-nism of material removal, working principle and analyze the process parameters of ECM, EDM, WEDM and USM.

TEXT BOOKS:

1. Workshop Technology, HajraChoudhry, Vol-II, Media Promoters& Pub. Pvt. Ltd. 2004
2. Production Technology, R.K.Jain, Khanna Publications, 2003.
3. Production Technology, HMT, Tata McGraw Hill, 2001.
5. Manufacturing Technology - Vol. 2, P N Rao, TMH Education; 3rd edition (1 May 2013)
6. Production Technology ,R.K.Jain, Khanna Publications, 2003.
7. Production Technology, P.C. Sharma, S Chand (1 December 2006)

REFERENCE BOOKS:

1. Manufacturing Science, AmitabhaGhosh and Mallik, affiliated East West Press, 2003.
2. Fundamentals of Metal Machining and Machine Tools, G.Boothroyd, McGraw Hill, 2000.

SCHEME OF EXAMINATION (SEE):

1. ONE FULL QUESTION from UNIT-1, UNIT-4 and UNIT-5 are COMPULSORY.
2. TWO FULL QUESTIONS with CHOICE from UNIT-2 and UNIT-3 ONLY.
3. MAXIMUM of THREE SUB-DIVISIONS in EACH FULL QUESTION

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	1	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : MATERIAL SCIENCE AND METALLURGY		
Course Code : ME45	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/ week : 03
Exam Duration: 3 Hrs		Exam Marks : 100

Course objectives:

1. Know the fundamental science and engineering principles relevant to materials.
2. Understand the relationship between nano/microstructure, characterization, properties and processing and design of materials.
3. Have experimental skills for a professional career or graduate study in materials.
4. Possess a knowledge of the significance of research, the value of continued learning and environmental/social issues surrounding materials.
5. The student should be able to understand all basic principles involved in the theory of Elasticity and Plasticity.

Unit No.	Syllabus	No.of hours
1.	**CRYSTAL STRUCTURE** BCC, FCC and HCP Structures, coordination number and atomic packing factors, crystal imperfections -point line and surface imperfections. Atomic Diffusion: Phenomenon, Flick's laws of diffusion, factors affecting diffusion. Mechanical Behaviour**:** Stress-strain diagram showing ductile and brittle behaviour of materials, linear and non linear elastic behaviour and properties, mechanical properties in plastic range, yield strength offset yield Strength, ductility, ultimate tensile strength, toughness. Plastic deformation of single crystal by slip and twinning. Metallography: Specimen preparation for metallographic study, study of metallurgical, transmission electron and scanning electron Microscopes, etc.,	12
2.	**DUCTILE AND BRITTLE FRACTURE** Modes of fracture :Type I, Type II and Type III. **CREEP:** Description of the phenomenon with examples, three stages of creep, creep properties, stress relaxation. **FATIGUE:** Types of fatigue loading with examples, Mechanism of fatigue, fatigue properties, fatigue testing and SN diagram. **SOLIDIFICATION**: Mechanism of solidification, Homogenous and Heterogeneous nucleation, crystal growth, cast metal structures. Solid solutions Hume Rothary rule, substitutional and interstitial solid solutions, intermediate phases, Gibbs phaserule.	10

3.	**PHASE DIAGRAM** Construction of equilibrium diagrams involving complete and partial solubility, lever rule. Iron carbon equilibrium diagram description of phases, solidification of steels and cast irons, invariant reactions. **HEAT TREATING OF METALS:** Introduction, TTT curves, continuous cooling curves, annealing and its types,normalizing, hardening, tempering, martempering, austempering, hardenability, surface hardening methods like carburizing, cyaniding, nitriding, flame hardening and induction hardening, age hardening of aluminium copper alloys (Process description, parameters, applications and limitations).	06
4.	**FERROUS AND NON FERROUS MATERIALS** Properties, Composition and uses of Grey cast iron, malleable iron, Spheroidal Graphite iron and steel; Copper alloys-brasses and bronzes;Aluminium alloys-Al-Cu, Al-Si, Al-Zn alloys. **CORROSION:** Definition, various types, control and prevention, monitoring andmeasurements.	06
5.	**COMPOSITE MATERIALS** General aspects, classification, properties, uses, characteristics, applications of composite materials, types of matrix materials & reinforcements, disadvantages, advantages and application of composites. **POLYMERS** ; Classification- Thermosets and thermoplastic, properties, applications. **SMART MATERIALS:** Introductionand properties of piezoelectric materials, shape memory alloys, ER and MR fluids, electrostrictive and magntostrictive materials as smart materials, applications.	05

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Understand the scientific and engineering principles underlying the four major elements of the field of Metallurgical and Materials Engineering, namely struc-ture, properties, processing and performance related to materials systems ap-propriate to the field.

2. To design and conduct experiments according to ASTM standards and analyze the acquired data.

3. Know about the structure of a metal, be able to describe resultant elastic proper-ties in terms of its 1D and 2D defects. Which material properties vary significantly with microstructure? Given a binary phase diagram, what microstructures can be obtained by suitable thermal treatments?

4. Understand about the driving forces and kinetic barriers to phase transforma-tions. What are the governing factors for, fatigue and creep? Ductile and brittle fracture. How are the mechanical properties of a composite material related to the properties and arrangement of the component materials?

TEXT BOOKS:

1. Foundations of Materials Science and Engineering, Smith, 3rd EditionMcGraw Hill, 2009

2. Materials Science, Shackleford and M. K. Muralidhara**,** Pearson Publication –2007.

3. Material Science, byCallister, Reprint 2008, Wiley India (P) LTD**.**

4. Material Science by V. Raghavan, Fifth Edition, PHI(P) LTD.

5. Smart Material and Structures by M.V. Gandhi and B.S. Thompson, FirstEdition 1992, Chapman& Hall.

REFERENCE BOOKS:

1. Elements of Materials Scienceand Engineering, H. Van Vlack

2. Engineering Materials Science, W.C. Richards, PHI, 1965.

3. Physical Metallurgy; Lakhtin, Mir Publications.

4. Material Science and Engineering (SI Units), R.K. Rajput

5. Smart Materials and Structures, M V Gandhi and B S Thompson Chapmen &Hall

6. PHYSICAL METALLURGY : PRINCIPLES AND PRACTICE, V. Raghavan,

SCHEME OF EXAMINATION (SEE):

1. ONE FULL QUESTION from UNIT-3, UNIT-4 and UNIT-5 are COMPULSORY.
2. TWO FULL QUESTIONS with CHOICE from UNIT-1 and UNIT-2 ONLY.
3. MAXIMUM of THREE SUB-DIVISIONS in EACH FULL QUESTION

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

(irrespective of portions covered due to whatever might be the reason)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : MATERIAL TESTING LABORATORY		
Course Code : MEL46	No of Credits : L-T-P-SS 00:00:02:00 =01	No. of lecture hours/ week : 02
Exam Duration: 3 Hrs		Exam Marks : 50

Course objectives:

1) To focus on the standards to be followed for mechanical properties estimation
2) To understand the need for the methods of mechanical properties testing
3) To know the salient steps in preparing test coupons for microstructure study
4) To get a peek into the non-destructive testing

Unit No.	Syllabus	No.of hours
1.	**INTRODUCTION TO ASTM STANDARDS FOR TESTING OF MATERIALS** Tensile, shear and compression tests of metallic and non metallic specimens using Universal Testing Machine, Torsion Test, Bending Test on metallic and nonmetallic specimens, Fatigue Test, Izod and Charpy Tests on M.S,C.I Specimen, Brinell, Rockwell and Vickers's Hardness test.	18
2.	**PREPARATION OF SPECIMEN FOR METALLOGRAPHIC EXAMINATION OF DIFFERENT ENGINEERING MATERIALS** Identification of microstructures and grain size count of plain carbon steel, tool steel, gray C.I, SG iron, Brass and Bronze & composites. To study the defects of Cast and Welded specimens using Non-destructive test experiments like, (a) Ultrasonic flaw detection (b) Magnetic crack detection (c) Dye penetration testing equipment, microstructure studies of composites	08

COURSE OUTCOMES: On completion of the course, student should be able to;
1) Familiarize with the standards for mechanical properties estimation
2) Validate the need for mechanical properties testing
3) Conversant with preparing test coupons for microstructure study
4) Acquaint with non-destructive testing

REFERENCE BOOKS:

1.“Mechanical Metallurgy”**, George E Dieter, McGraw Hill Publications, 1986.**

2.“Strength of Materials”, **S.S. Rathan, Tata McGraw Hill Publications, Sec-ond Edition**

CONTINUOUS INTERNAL EVALUATION (CIE)

1. CIE has a maximum of 50 marks i.e., Evaluation of Record (30) + Test (20)
2. CIE Marks is finalized by conducting ONE test at the end of 10^{th} week of the semester.

SCHEME OF EXAMINATION (SEE):

ONE question from PART A	15 MARKS
ONE question from PART B	25 MARKS
Viva –Voce	10 MARKS
TOTAL	**50 MARKS**

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : MANUFACTURING PROCESS LABORATORY - II		
Course Code : MEL47	No of Credits : L-T-P-SS 00:00:02:00 =01	No. of lecture hours/ week : 02
Exam Duration: 3 Hrs		Exam Marks : 50

Course objectives:

1. To teach the students to produce simple work pieces using different machines such as lathe, shaping, milling and drilling.

Unit No.	Syllabus	No.of hours
1.	**TURNING MACHINE** Preparation of three models on lathe involving Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning.	18
2.	**MILLING MACHINE** Cutting of V Groove/ dovetail / Rectangular groove using a shaper / milling machine Cutting of Gear Teeth using Milling Machine	09

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Identify machines and usage of machine tools
2. Demonstrate setting of work piece into different machines.
3. Analyze and utilize tools in machining different workpieces and then with care to load and unload workpieces as per the set dimensions.
4. Demonstrate simple operations on a lathe, milling, drilling and shaping machines

CONTINUOUS INTERNAL EVALUATION (CIE)

1. CIE has a maximum of 50 marks.
2. CIE Marks is finalized by conducting a test at the end of 10^{th} week of the semes-ter.
3. CIE Marks (50) = Evaluation of Record (30) + Test (20)

REFERENCE BOOKS:

1. Production Technology, R.K.Jain, Khanna Publications, 2003.
2. Production Technology, HMT, Tata McGraw Hill, 2001.
3. Manufacturing Technology - Vol. 2, P N Rao,TMH; Third edition (1 May 2013)
4. Production Technology ,R.K.Jain, Khanna Publications, 2003.
5. Production Technology, P.C. Sharma, S Chand (1 December 2006)

CONTINUOUS INTERNAL EVALUATION (CIE)

1. CIE has a maximum of 50 marks i.e., Evaluation of Record (30) + Test (20)
2. CIE Marks is finalized by conducting ONE test at the end of 10^{th} week of the semester.

SCHEME OF EXAMINATION (SEE):

One Compulsory Model from PART A	20 MARKS
One optional Model from PART B	20 MARKS
Viva – Voce	10 MARKS
TOTAL	**50 MARKS**

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : FLUID MECHANICS AND MACHINES LABORATORY		
Course Code : MEL48	No of Credits : L-T-P-SS 00:00:02:00 =01	No. of lecture hours/ week : 02
Exam Duration: 3 Hrs		Exam Marks : 50

Course objectives:

1. To conduct experiment to determine coefficient of impact of water jet on vanes.
2. To determine coefficient of discharge of orifice meter, venturimeter and V-notch.
3. To conduct experiment to determine minor and major loss of head in flow through a pipe.
4. To conduct performance test on Pelton, Francis and Kaplan turbines and evaluate the efficiency of these turbines.
5. To determine the efficiency of single stage and multi stage centrifugal pump and plot the characteristic curves.
6. To conduct performance test on reciprocating pump and determine the percent-age slip.

Unit No.	Syllabus	No.of hours
1.	**MINOR EXPERIMENT** 1. Impact of jet on vanes - Determination of coefficient of impact of water jet on flat vane, inclined vane and hemispherical vane. 2. Orifice meter – Determination of coefficient of discharge (Calibration of orifice meter) 3. Venturimeter – Determination of coefficient of discharge (Calibration of venturimeter) 4. V- notch – Determination of coefficient of discharge (Calibration of V notch) 5. Flow through a pipe - Determination of major losses. 6. Flow through a pipe - Determination of minor losses.	12
2.	**MAJOR EXPERIMENT** **I.** Performance testing, plotting the characteristic curves and determination of unit quantities and specific speed of 1) Pelton turbine 2) Francis turbine 3) Kaplan turbine **II.** Performance testing, plotting the characteristic curves and determination of specific speed of 4) Single stage centrifugal pump 5) Multi stage centrifugal pump **III.**Coefficient of discharge and percentage slip of a 6) Reciprocating pump	12

REFERENCE BOOKS:

1) **Hydraulics and Fluid Mechanics including Hydraulic Machines**, Dr. P.N.Modi and S.M. Seth, Rajsons Publications Private Limited, Standard Book House, 2009.

SCHEME OF EXAMINATION (SEE

SI. No.	Particulars	Max. Marks	Break Up of Max. Marks		
			Write Up	Conduction of experiment	Specimen Calculation, Tabulation of Results and Plotting of Graph
1.	**Unit-1: Minor Experiment** (Any ONE from the list of experiments)	15	05	05	05
2.	**Unit-2: Major Experiment** (Any ONE from the list of experiments)	25	05	10	10
3.	**Viva Voce**	10	-	-	-
		50	10	25	15

COURSE OUTCOMES: On completion of the course, student should be able to;
1. Describe fluid properties and classify them.
2. Calibrate different types of flow measurement devices.
3. Understand the general working of fluid machines.
4. Describe the functioning of radial flow and axial flow fluid machines
5. Derive various equations related to the performance of turbo machines.
6. Analyze and predict the performance of various turbo machines.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	2	1	2	1	1	1	1	2	1	1
2	3	3	3	1	2	1	1	1	1	1	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	2	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : BASIC ENGINEERING MATHEMATICS-II		
Course Code : MADIP41	No of Credits : 00	No. of lecture hours/ week : 04
Exam Duration: 3 Hrs		Exam Marks : 100

Course Objective: To develop a basic Mathematical knowledge required for higher semesters with few examples of its engineering applications.

Unit No.	Syllabus	No.of hours
1.	**Partial differential equations:** Formation of Partial differential equations (PDE) by elimination of arbitrary constants/functions. Solution of non-homogeneous PDE by direct integration. Solution of homogeneous PDE involving derivative with respect to one independent variable only. Solution of PDE by the Method of separation of variables (firstand second order equations).	10
2.	**Vector Calculus I: Vector Differentiation:** Scalar and vector point functions – Gradient, Directional derivative, Divergence, Curl, Solenoidal and Irrotational vector fields. Vector identities involving Gradient, Divergence and Curl. Applications-Velocity, acceleration, conservative, Solenoidal, irrotational and angular momentum fields.	10
3.	**Vector Calculus II: Vector Integration:** Line, surface and volume integrals-simple problems, Green's theoremin a plane, Stoke's and Gauss divergence theorem (without proofs). Applications-involving simple problems of triangles, cubes, rectangular parallelopipeds and solid figures.	10
4.	**Laplace Transforms I :** Definition, transforms of some standard functions, properties (without proof). Periodic function, Heaviside's unit step function, unit impulse functions, Dirac-delta function and convolution theorem.	10
5.	**Laplace Transforms II:** Inverse transforms and their properties (no proofs). Applications-linear and simultaneous linear DE'S with constantcoefficients.	10

Course Outcomes: After the successful completion of the course, the students are able to

CO1:analyze the basic concepts of partial differential equations and their solutions throughstandard methods.

CO2:use the idea of gradient, divergence, curl involved in vector fields arising in fields and wave transmission theory.

CO3: assess the practical importance of Laplace and inverse Laplace transforms and their utilityin network analysis, circuit theory and convection problems.

CO4: apply logical thinking to problem-solving in context and identify an appropriate solutionfor various engineering streams.

CO5: use the skills in understanding Mathematical knowledge.

Course Outcomes (CO) Mapping with Programme Outcomes (PO)

CO1: PO1, PO2
CO2: PO1, PO2
CO3: PO1, PO2
CO4: PO1, PO4
CO5: PO1, PO2

TEXT BOOKS:

1. B.S. Grewal, Higher Engineering Mathematics (Latest Edition, 2016), Khanna Publishers, NewDelhi.

2. Erwin Kreyszig, Advanced Engineering Mathematics (10th Edition, 2016), Wiley Publishers, New Delhi.

REFERENCE BOOKS:

1. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill publications, New Delhi.

2. Peter V. O'Neil, Advanced Engineering Mathematics (7thEdition), Cengage Learning, Publishers U.S.A.

3. H.K.Dass and Er. RajnishVerma, Advanced Engineering Mathematics (Latest Edition 2015),S.Chand Publisher, New Delhi.

BATCH 2015– 2019(PROPOSED)

5th Semester

			L	T	P	C
1	HS03	Management and Entrepreneurship	4	0	0	4.0
2	ME51	Design Of Machine Elements-1	4	0	0	4.0
3	ME52	Dynamics Of Machines	4	0	0	4.0
4	ME53	Heat Transfer	4	0	0	4.0
5	ME54	CAD/CAM	4	0	0	4.0
6	ME551	Experimental Stress Analysis	3	0	0	3.0
	ME552	Advanced Machining Processes	3	0	0	3.0
	ME553	Power Plant Engineering	3	0	0	3.0
7	ME561	Theory Of Elasticity	3	0	0	3.0
	ME562	Composite Materials And Manufacturing	3	0	0	3.0
	ME563	Heating, Ventilation & Air Conditioning	3	0	0	3.0
8	MEL57	Heat Transfer Laboratory	0	0	2	1.0
9	MEL58	Fuel Testing & Internal Combustion Engines Laboratory	0	0	2	1.0
		FIFTH SEMESTER END CREDITS				**28.0**

BATCH 2015– 2019(PROPOSED)

6th Semester

			L	T	P	C
1	IDE	Inter Departmental Electives	4	0	0	4.0
2	ME61	Design Of Machine Elements-II	4	0	0	4.0
3	ME62	Finite Element Method	4	0	0	4.0
4	ME63	Mechanical Vibrations	4	0	0	4.0
5	ME64	Operations Research	4	0	0	4.0
6	ME651	Inspection & Quality Control	3	0	0	3.0
	ME652	Product Design & Manufacturing	3	0	0	3.0
	ME653	Automotive Engineering	3	0	0	3.0
7	ME661	Industrial Management	3	0	0	3.0
	ME662	Advanced Welding Processes	3	0	0	3.0
	ME663	Advanced Heat Transfer	3	0	0	3.0
8	MEL67	Design Laboratory	0	0	2	1.0
9	MEL68	CIM & Automation Laboratory	0	0	2	1.0
10	MEP69	Mini-project Work	0	0	4	2.0
		SIXTH SEMESTER END CREDITS				**30.0**
		THIRD YEAR CUMULATIVE CREDITS				**163.0**

V SEMESTER

Sub Title: MANAGEMENT AND ENTREPRENEURSHIP		
Course Code : HS03	No of credits : 4=4:0:0 (L:T:P)	No. of lecture hours/ week : 4
Exam Duration: 3 Hrs	CIE +Assignment + SEE = 45 + 5 + 50 =100	Total No. of Contact Hours : 52

Course objectives:

1. To help students understand the Management concepts & its evolution.
2. To impart the knowledge about various Managerial functions.
3. To make the student learn the Entrepreneurial process.
4. To gain an insight of funding agencies & understand the role of SSI in economic development.
5. To have a clear understanding of various business opportunities & designing the Business plan.

Unit No.	Syllabus	No.of hours
1.	**MANAGEMENT:** Introduction-meaning-nature, characteristics of management, scope, functions of management and functional areas of management, management as a science or an art or profession, management and administration, roles of management, levels of management, Development of management thought -Early management approaches, Modern management approaches.	08
2.	**PLANNING, ORGANIZING, DIRECTING AND CONTROLLING:** **PLANNING:** Meaning and Nature, Types of Plans and Steps in Planning process. **ORGANIZING:** as a Managerial function – Nature and purpose of organization, principles of organization, types of organization. Departmentation, Committees, Centralization Vs Decentralization of authority and responsibility span of control, MBO and MBE (only concepts), Staffing: Nature and importance of staffing, process of selection and recruitment, Decision Making: Definition, Types and Decision Making Process. **DIRECTING:** Meaning and nature of directing, leadership styles – Autocratic, Democratic, Charismatic, Laissez faire and Participative. Leadership theories – Trait, Behavioral and Contingency. Introduction to Motivation theories – Maslow, Herzberg, Carrot & Stick & Mc. Gregor's Theory of X & Y. **CO-ORDINATION:** Meaning and importance of Co-ordination, Team Building & Group Dynamics, Communication – meaning and importance, types and barriers of communication. **CONTROLLING:** Meaning and steps in controlling-Essentials of a sound control system-Types of control, Method of establishing control (in brief).	12
3.	**ENTREPRENEUR**: Meaning, evolution of the concept, Scope of Entrepreneur, functions of an Entrepreneur, Characteristics of an Entrepreneur, types of entrepreneur, Intrapreneur – an emerging class. Difference between Entrepreneur, Intrapreneur & Manager, Stages in Entrepreneurial process, Problems faced by an Entrepreneur, Role of Entrepreneurs in economic development, Entrepreneurship- Meaning & Importance of Entrepreneurship in India, barriers, Women entrepreneur – Concept & steps to develop Women Entrepreneur.	10
4.	**SMALL SCALE INDUSTRY**: Concept of MSME, Ancillary Industry and Tiny Industry, Definition;, Characteristics; Objectives, Scope and role of SSI in economic Development, Advantages of SSI, problems of SSI, Steps to start an SSI, Government Policy towards SSI; Introduction to GATT/ WTO/ LPG. Forms of ownership. **SUPPORTING AGENCIES OF GOVERNMENT FOR SSI:** Meaning, Nature of support; Objectives, functions. **INSTITUTIONAL SUPPORT:** Different Schemes, TECKSOK, KIADB, KSSIDC, DIC, SISI NSIC, SIDBI, KSFC. Sources of financing an enterprise- long term and short term.	12
5.	**PREPARATION OF PROJECT:** Meaning, Project identification, Project selection, Project Report - Need of Project, Contents: formulation, Errors of project report, Project Appraisal, Feasibility Study-Market Feasibility Study, Technical Feasibility Study, Financial Feasibility Study, Social Feasibility Study. Business opportunities, Business plan: Definition, components of business plan, reasons for failure of business plan.	10

Note 1 : Unit 2 and Unit 4 will have internal choice.
Note 2: Three Assignments are evaluated for 5 marks:
Assignment – I from Units 1 and 2.
Assignment – II from Units 3 and 4 .
Assignment -III from Unit 5

COURSE OUTCOMES :

CO1 : The students will gain knowledge on management concepts & its evolution.

CO2 : The students will learn the application of managerial skills & attributes.

CO3 : The students will get an in depth knowledge of entrepreneurial process & will be able to apply the entrepreneurial skills.

CO4 : Students compile information & explore the sources of funding agencies.

CO5 : Students will be able to identify business opportunities & prepare the business plan.

COS	Mapping with POS
CO1	PO12
CO2	PO9,PO10,PO11,PO12
CO3	PO11,PO12
CO4	PO11
CO5	PO7,PO11,PO12

TEXT BOOKS:

1. Entrepreneurship and Management- S Nagendra and V S Manjunath- Pearson Publication 4 /e, 2009.
2. Dynamics of Entrepreneurial Development and Management-Vasant Desai-Himalaya Publishing House.
3. Principles of Management – PC Tripathi, and P N Reddy – Tata MacGraw Hill.

REFERENCE BOOKS:

1. Entrepreneurship Development – Poornima M Charanthimath Pearson Education 2006.
2. Entrepreneurship and management - Shashi k Gupta- Kalyani publishers, Latest edition.
3. Organizational behaviour, Stephen P Robbins, Timothy A. Judge, Neharika Vohra, Pearson, 14/e, 2012.
4. Financial Management- Shashi k Gupta- Kalyani publishers, Latest edition.

COURSE TITLE : DESIGN OF MACHINE ELEMENTS – I		
Course Code : ME51	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/ week : 04
Exam Duration: 3 Hrs		Exam Marks : 100

Course objectives:

This course "Design of Machine Elements -1" is designed with the following objectives in mind:

1. The student shall understand the design function, basic principles, steps involved and its relation manufacturing.

2. To acquaint with the concepts of strength design related to various components and understand various type of standard material standard and CODES to choose suitable materials for the different machine elements depending on their, avail-ability, Cos and, properties. Choose suitable Factor of safety (FOS) and factors to be consider while selecting suitable Factor of safety (FOS) for the design depend-ing on their application..

3. The student shall gain a thorough understanding of the different types of failure modes and criteria. He will be conversant with various failure theories and be able to judge which criterion is to be applied in different situations.

4. Student shall gain design knowledge of the different types of elements used in various machine design process. e.g., fasteners (temporary and permanent fas-teners) such as shafts, couplings Riveted and Welded joints etc. and will be able to design these elements for depending on different loads forvarious suitable applications.

Unit No.	Syllabus	No.of hours
1.	**INTRODUCTION** Introduction to machine design, Classification, materials and their strain diagrams, Stress analysis, Definitions: normal, shear, biaxial and tri axial stresses, Stress tensor, Principal Stresses and their directions, Shear stress and their directions. **DESIGN FOR STATIC STRENGTH:** Static loads and factor of safety, Theories of failure: Maximum normal stress theory, Maximum shear stress theory, Maximum strain theory, Strain energy theory, Distortion energy theory. Failure of brittle and ductile materials, Stress concentration, Determination of Stress concentration factor. Stress concentration charts, stress concentration and static loads and compound stress concentration actors.	**14**

2.	**DESIGN FOR FATIGUE STRENGTH** Introduction- S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit, Modifying factors: size effect, surface effect, Stress concentration effects, Fluctuating stresses, Goodman and Soderberg relation, stresses due to combined loading, cumulative fatigue damage. **IMPACT STRENGTH:** Introduction, Impact stresses due to axial, bending and torsional loads, effect of inerti	**08**
3.	**DESIGN OF SHAFTS** Torsion of shafts, design for strength and rigidity with steady loading, ASME codes for power transmission shafting, shafts under fluctuating loads and combined loads. **KEYS:** Types of keys, Design of keys	**08**
4.	**JOINTS** **RIVETED JOINTS** Types, rivet materials, failures of riveted joints, Joint Efficiency, Boiler Joints, Lozenge Joints, Riveted Brackets, Eccentrically riveted joints. **WELDED JOINTS** Types, Strength of butt and fillet welds, eccentrically loaded welded joints	**14**
5.	**COUPLINGS** Introduction, classification, advantages, and applications of Couplings: design of Rigid and flexible couplings, Flange coupling, Bush and Pin type coupling and Oldham's coupling.	**08**

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Demonstrate ability to use free-body diagrams, equilibrium, force, moment and torque equations diagrams, and calculate resulting stresses.
2. Identify relevant properties of materials from various sources and apply basic principles of machine design to compute principal stresses in different machine members coursed to combined loadings.
3. Demonstrate the ability to calculate various stresses stress concentration, fa-tigue loading fatigue stress concentration, for variable loading conditions
4. Express ability to apply stress and deflection analyses, failure criteria under steady and variable loadings, in applications involving the design of simple machine elements, (temporary and permanent fasteners) such as shafts, couplings Riveted and Welded joints etc. and will be able to design these elements for de-pending on different loads for various suitable applications. Thus he shall be able to apply the knowledge of machine design in real life usage to meet / satisfies the industrial needs

TEXT BOOKS:

1. Mechanical Engineering Design, Joseph E Shigley and Charles R. Mischke. McGraw Hill International edition, 6th Edition 2009.

2. Design of Machine Elements, V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2007.

DESIGN DATA HANDBOOK:

1. Design Data Hand Book, K. Lingaiah, McGraw Hill, 2nd Ed.

2. Data Hand Book, K. Mahadevan and Balaveera Reddy, CBS Publication

3. Design Data Hand Book, H.G. Patil, ShriShashiPrakashan, Belgaum.

REFERENCE BOOKS:

1. Machine Design, Robert L. Norton, Pearson Education Asia, 2001.

2. Design of Machine Elements, M. F. Spotts, T. E. Shoup, L. E. Hornberger, S. R. Jayram and C. V. Venkatesh, Pearson Education, 2006.

3. Machine Design, Hall, Holowenko, Laughlin (Schaum's Outlines series)Adapted by S.K. Somani, Tata McGraw Hill Publishing Company Ltd., New Delhi, Special Indian Edition, 2008.

4. Fundamentals of Machine Component Design, Robert C. Juvinall and KurtM Marshek, Wiley India Pvt. Ltd., New Delhi, 3rd Edition, 2007.

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven Full Questions to be set.
2. Five full Questions to be answered.
3. Unit-2, Unit-3 and Unit-5 are compulsory, with one question from each Unit.
4. Unit-1 and Unit-4: Two questions to be set with choice.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs /POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	2	3	2	3	1	3	3
CO2	2	3	3	2	3	3	3	1	2	3	3	2
CO3	3	3	2	3	3	3	1	3	3	2	3	2
CO4	3	3	2	3	3	2	3	2	1	2	3	3

High 3 Medium 2 Low 1

COURSE TITLE : DYNAMICS OF MACHINES		
Course Code : ME52	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/ week : 04
Exam Duration: 3 Hrs		Exam Marks : 100
Pre-requisites	Engineering Physics, Engineering Mathematics	

Course objectives:

1. Draw and analyze free body diagram for multiple forces applied on static mem-bers of four bar chain and slider mechanism. And esign the size of the flywheel for the excess energy storage and retrieval.

2. Define the terms slip and creep in belt drives andEvaluate power transmitted and condition for maximum power transmission.

3. Determine the value of balancing mass for the system.

4. Define sensitivity, isochronous, hunting, controlling force with respect to gover-nors and Analyses the effect of gyro on automobile, ship, Aero plane and rotating members.

5. Evaluate the velocity and acceleration of the follower on cams having specified contours

Unit No.	Syllabus	No.of hours
1.	**FORCE ANALYSIS** **STATIC FORCE ANALYSIS** Introduction: Static equilibrium. Equilibrium of two and three force members. Members with two forces and torque. Free body diagrams. Principle of virtual work. Static force analysis of four bar mechanism and slider-crank mechanism with and without friction. **DYNAMIC FORCE ANALYSIS:** D'Alembert's principle, Inertia force, inertia torque. Dynamic force analysis of four-bar mechanism and slider crank mechanism. Dynamically equivalent systems.Turning moment diagrams and flywheels.Fluctuation of Energy.Determination of size of flywheels.	12
2.	**FRICTION AND BELT DRIVES** Definitions: Types of friction: laws of friction, Friction in pivot and collar bearings. Belt drives: Flat belt drives, ratio of belt tensions, centrifugal tension, power transmitted and V-belt drives-derivation and numerical problems.	08
3.	**BALANCING OF ROTATING MASSES** Static and dynamic balancing. Balancing of single rotating mass by balancing masses in same plane and in different planes. Balancing of several rotating masses by balancing masses in same plane and in different planes.	10
4.	**BALANCING OF RECIPROCATING MASSES** Inertia effect of crank and connecting rod, single cylinder engine, balancing in multi cylinder-inline engine (primary & secondary forces), V-type engine; Radial engine – Direct and reverse crank method	10
5.	**GOVERNORS** Types of governor; force analysis of Porter and Hartnell governors. Controlling force curves. Requirements of characteristics of governor. Gyroscope**:** Introduction and gyroscopic couple. Effect of gyroscopic couple on ship, plane disc, aero plane, stability of two wheelers and four wheelers.	12

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Define the terms slip and creep in belt drives.

2. Discuss free body diagram for multiple forces applied on static members of four bar chain and slider mechanism.

3. Illustrate the terms slip and creep in belt drives.

4. Analyze the effect of gyro on automobile, ship, Aeroplane and rotating members.

5. Design the flywheel for the excess energy storage and retrieval.and Evaluate the velocity and acceleration of the follower on cams having specified demonstrate the Equilibrium of Two, Three and Four force members

TEXT BOOKS:

1. **Theory of Machines**, Rattan S.S. Tata McGraw Hill Publishing Company Ltd.,New Delhi, 3rd Edition, 2009.

2. **Theory of Machines**, Sadhu Singh, Pearson Education. 2ndedition. 2007.

REFERENCE BOOKS:

1. **Theory of Machines & Mechanisms,** J.J. Uicker, G.R. Pennock, J.E. Shigley. Oxford 3rd edition. 2009

2. **Mechanism and Machine Theory**, A.G. Ambekar PHI, 2007.

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven full Questions to be set.
2. Five full Questions to be answered.
3. Unit-2, Unit-3 and Unit-4 are compulsory, with one full question from each Unit.
4. Unit-1 and Unit-5: Two full questions to be set with choice

REMINDER:

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (50%) First
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3.	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : HEAT TRANSFER		
Course Code : ME53	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/ week : 04
Exam Duration: 3 Hrs		Exam Marks : 100
Pre-requisites	Basic Thermodynamics, Fluid Mechanics	

Course objectives:

1. To outline the basic concepts of conduction, convection and radiation heat transfer. This course helps students to derive generalized expression for heat conduction equation.

2. To discuss and illustrate the application of various boundary conditions giving heat trans-fer examples.

3. To understand the unsteady heat conduction and convection heat transfer and apply the knowledge to solve real time problems.

4. To demonstrate the use of graphical charts for solving analytical problems.

5. To design heat exchangers based on the input variables such as inlet temperature of hot and cold fluids.

6. To evaluate various heat transfer parameters and predict the rate of heat transfer and heat transfer coefficients.

Unit No.	Syllabus	No.of hours
1.	**BASIC CONCEPTS AND CONDUCTION HEAT TRANSFER** Introduction - Modes of heat transfer, Basic laws, Combined heat transfer mechanism, Resistance concept, Boundary conditions of 1st, 2nd and 3rd kind; Thermal contact resistance; Overall heat transfer coefficient; Illustrations of applying the boundary conditions to heat transfer problems; Derivation of general equation of heat conduction in Cartesian coordinates; Special cases; Discussion on 3-D conduction in cylindrical and spherical coordinate systems (No derivation);Steady state heat con-duction in simple and composite slabs, cylinders and spheres (uniform thermal conductivity and without heat generation); Introduction to ex-tended surfaces; Derivation of heat transfer and temperature distribution in fins (uniform cross-section without heat generation); Long fin, short fin with insulated tip and without insulated tip and fin connected between two heat sources; Fin efficiency and effectiveness; Numericals	**10**
2.	**ONE-DIMENSIONAL UNSTEADY CONDUCTION HEAT TRANSFER** Introduction; Conduction in solids with negligible internal temperature gradient (Lumped system analysis), Use of Transient temperature charts (Heisler's charts) for transient conduction in slab, long cylinder and sphere; use of transient temperature charts for transient conduction in semi-infinite solids. Related numericals.	**10**

3.	**CONVECTION HEAT TRANSFER** Introduction – Boundary layer concept in external and internal flow; Forced Convection - Dimensional analysis for forced convection; Physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers; Use of correlations for flow over simple geometries (flat plate, cylinder and sphere); Use of correlations for flow inside a duct;Related numerical problems; Free or natural convection - Dimensional analysis for free convection; Physical significance of Grashofnumber; Use of correlations of free convection over flat plates (vertical, horizontal and inclined), cylinders (vertical and horizontal) and spheres; Related numericals.	**08**
4.	**HEAT EXCHANGERS** Introduction; Classification of heat exchangers; Compact, Shell and-tube and Plate heat exchangers; Overall heat transfer co efficient and fouling factor; Parallel and counter flow heat exchangers; Use of LMTD; Cross flow heat exchangers; Comparison of parallel and counter flow heat exchangers; Heat transfer with phase change; Multi pass heat exchangers; Effectiveness-NTU method; Limiting cases; Heat transfer enhancement in fins; Related numerical problems; Heat pipes – Introduction; Working principle; components; Applications; Limitations	**12**
5.	**RADIATION HEAT TRANSFER** Introduction; Black bodies separted by a non-absorbing medium; Shape factor; Electrical analogy; Two black surfaces connected by non-conducting and re-radiating walls; Evaluation of shape factor; Radiation heat transfer between gray bodies; Radiosity and Irradiation; Radiation network for gray surfaces exchanging energy; Hottel's crossed string method; Radiation shields; Radiation from cavities; Radiation from Gases and vapours; Radiation combined with converction; Green house effect; Solar radiation.	**12**

TEXT BOOKS

1. Heat and Mass Transfer, P.K. Nag, 3rdEdition, Tata McGraw-Hill Publications, 2011.

2. A Course in Heat and Mass Transfer, Domkundwar, Arora, Domkundwar, DhanpatRai Publications, 2005.

REFERENCE BOOKS

1. Heat and Mass Transfer: Fundamentals and Applications, Cengel,Y.A.,and Ghajar, A.J., 5th Edition, McGraw-Hill Publications (SIE), 2015.

2. Principles of Heat and Mass Transfer,Frank P. Incropera,David P. Dewitt, Theodore L. Bergman, and Adrienne S. Lavine, 7th Edition, Wiley Student Edition, 2013.

e-LEARNING RESOURCES

1. A Heat Transfer Text Book, John H Leinard IV and John H Leinard V, 3rdEdition, Phlogiston Press, Cambridge, Massachusetts, USA, 2008.

2. Heat and Mass Transfer: Mechanical Engineering Handbook, Kreith, F.,Boehm, R.F., et. al., Frank Kreith (Ed), Boca Raton: CRC Press LLC, 1999.

3. Fundamentals of Heat and Mass Transfer, Frank P. Incropera,David P. Dewitt,et. al. Frank P. Incropera (Ed), 6th Edition, John Wiley and Sons, 2007.

4. e-Journal: Frontiers in Heat and Mass Transfer,http://www.ThermalFluidsCentral.org

5. Videos, Student slides, Handouts, Lecture notes: http://www.nptel.ac.in

DATA HAND BOOK AND CHARTS

1. Heat and Mass Transfer Data Hand Book, C.P. Kothandaraman, S.Subramanyan, New Age International Publishers, 8th Edition, 2014.

2. Steam Tables with Mollier Diagram: SI Units, Mahesh M.Rathore,DhanpatRai Publishing Company, 2014.

SYLLABUS COVERAGE FOR CIE

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)
CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES: On completion of the course, student should be able to; After completion of the course, students will be able to:

1. Identify the different modes of heat transfer and state the laws related to each of them.

2.Explain the various modes of heat transfer and heat transfer devices with ex-amples and illustrations.

3. Solve numerical problems related to different modes of heat transfer and heat transfer devices.

4. Compare and analyse different modes of heat transfer.

5. Derive expressions for determining the heat transfer rate during steady and un-steady state conduction, convection and radiation modes.

6. Calculate the rate of heat transfer in different modes of heat transfer and com-pute the performance of various heat transfer systems.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	3	1	1
5	3	3	3	1	3	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : COMPUTER AIDED DESIGN AND MANUFACTURING		
Course Code : ME54	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/ week : 04
Exam Duration: 3 Hrs		Exam Marks : 100

Course objectives:

1. To teach the role of CAD/CAM in modern design and manufacturing
2. To impart the use of CAD in the design process
3. To impart the use of CAM in the production preparation process
4. Demonstrate the applications and limitations of different CAD/CAM system types

Unit No.	Syllabus	No.of hours
1.	**INTRODUCTION** Role of computers in design and manufacturing influence of com puters in manufacturing environment.Product cycle in convention to computerized manufacturing environment.Introduction to CAD. Introduction to CAM.Advantages and disadvantages of CAD and CAM, curves and types.	10
2.	**STANDARD EXCHANGE FORMAT AND TRANSFORMATION** Software configuration of a graphic system. Function of graphics package, construction of geometry, wire frame and solid modeling, CAD/CAM integration. Desirable modeling facilities, Introduction to exchange of modeling data – Basic features of IGES, STEP, DXF, DMIS.	10
3.	**NC, CNC, DNC TECHNOLOGIES:** NC, CNC, DNC, modes. NC element, advantages and limitations of NC, CNC.Functions of computer in DNC. CNC tooling: Turning tool geometry, milling tooling system, tool presetting. ATC, work holding, APT programming	12
4.	**CNC MACHINING CENTERS** Introduction to CNC, elements of CNC, CNC machining centers, part programming, fundamental steps involved in development of part programming for milling and turning	12
5.	**INTRODUCTION TO ROBOTICS** Introduction, robot configuration, robot motion, programming of robots, end effectors work cell, control and interlock, sensor, robot applications. Kinematic Analysis – Direct and Inverse Kinematic analysis, problems.	12

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Understand the possible applications of the CAD/CAM systems in structure analysis, optimize and virtual engineering.

2. Demonstrate the basic fundamentals that are used to create , manipulate and analyse geometric models in a computer graphics.

3. Explain the basic concepts, features of NC, CNC, DNC machines and machining centers.

4. To learn about Robot motions, sensors, end effectors Programming, kinematic analysis of robot

REFERENCE BOOKS

1. **Computer aided design (CAD) and computer aided manufacturing (CAM)** by MikellGroover, Pearson Education INC, Fifth Impression, 2008.

2. **CAD/CAM** by P N Rao, Tata McGraw Hill, Sixth Reprint, 2006.

3. **CAD/CAM** by Ibrahim Zied, Tata McGraw Hill, Fourth Reprint, 2008.

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven Full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-2 and Unit-5 are compulsory, with one question from each Unit.
4. Unit-3 and Unit-4: Two questions to be set with choice.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : EXPERIMENTAL STRESS ANALYSIS (CORE ELECTIVE)		
Course Code : ME551	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/ week : 03
Exam Duration: 3 Hrs		Exam Marks : 100

Course objectives:

1. Analyze stresses within the elastic range in 3D.
2. Compile strains and displacements.
3. Evaluate stress and strain relations for linear elastic materials.
4. Demonstrate the experimental methods for analyzing stresses and strains in given specimen.
5. Develop photo-elastic, Moire techniques and holography methods for analyzing stresses experimentally.

Unit No.	Syllabus	No.of hours
1.	**ELECTRICAL RESISTANCE STRAIN GAUGES** Gauged factors &Strain sensitivity in metallic alloys, Gauge construction, characteristics of strain gauges,Adhesives and mounting techniques, Gauge sensitivity and gauge factor, Performance Characteristics, Environmental effects, Strain Gauge circuits. Wheatstone's Potentiometer bridges, Constant current strain gauge circuits. Method of mounting a strain gauge. **STRAIN ANALYSIS METHODS:** Two element, three element rectangular and delta rosettes, stress-strain relations, correction for transverse strain effects, method of mounting the strain gauges, Elimination of moment and torque in rosettes.	10
2.	**PHOTOELASTICITY** Nature of light, Wave theory of light - optical interference, Stress optic law – effect of stressed model in plane and circularpolariscopes, Isoclinics&Isochromatics, Fringe order determination, determination of fractional fringe order (Tardy's compensation), photoelastic model materials.	07
3.	**TWO DIMENSIONALPHOTOELASTICITY** Separation methods: Shear difference method, Analytical separation methods, Model to prototype scaling, Properties of 2D photoelastic model materials, Materials for 2D photoelasticity.	06
4.	**PHOTOELASTIC(BIREFRINGENT) COATINGS** Birefringence coating stresses, Effects of coating thickness: Reinforcing effects, Poission's, Stress separation techniques: Oblique incidence, Strip coatings.	10

	MOIRE METHODS: Moire fringes produced by mechanical interference. Geometrical approach, Displacement field approach to Moire fringe analysis, out of plane displacement measurements, Out of plane slope measurements and Applications and advantages.	
5.	**BRITTLE COATINGS** Coatings stresses, Crack patterns, Refrigeration techniques, Load relaxation techniques, Crack detection methods, Types of brittle coatings, Calibration of coating. Advantages and brittle coating applications.	**06**

COURSE OUTCOMES:

1. Analyze stresses within the elastic range of materials.
2. Compile strains and displacements
3. Evaluate stress and strain relations for linear elastic materials.
4. Describe the importance of experimental methods in analyzing stress and strain
5. Describe photo elastic, Moiré technique and holographic methods of experimental stress analysis Validate results with experiments

TEXT BOOKS:

1. **"Experimental Stress Analysis",** Dally and Riley, McGraw Hill.
2. **"Experimental Stress Analysis".** Sadhu Singh, Khanna publisher.
3. **Experimental stress Analysis**, Srinath L.S tataMcGraw Hill.

REFERENCES BOOKS :

1. **"PhotoelasticityVol I and VolII,**M.M.Frocht, John Wiley & sons.
2. **"Strain Gauge Primer",** Perry and Lissner,
3. **"Photo Elastic Stress Analysis",** Kuske, Albrecht & Robertson John Wiley &Sons.
4. **"Motion Measurement and Stress Analysis",** Dave and Adams.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven Full Questions to be set.
2. Five full Questions to be answered.
3. Unit-2, Unit-3 and Unit-5 are compulsory, with one question from each Unit.
4. Unit-1 and Unit-4: Two questions to be set with choice.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	2	0	1	0	1	0	3	1	3	0
2	2	3	2	2	1	0	3	0	3	1	3	0
3	3	3	2	3	3	0	3	0	3	2	3	2
4	0	0	2	1	3	1	2	0	2	2	2	2
5	0	0	0	2	2	1	2	1	2	1	2	2

Strong-3, Medium-2, Weak-1

COURSE TITLE : ADVANCED MANUFACTURING PROCESSES (CORE ELECTIVE)		
Course Code : ME552	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/ week : 03
Exam Duration: 3 Hrs		Exam Marks : 100

Course objectives:

1. Discuss the finishing, super finishing and broaching process
2. Explain the various types of non-traditional machining processes
3. Know various techniques of metal joining processes
4. Discuss the metal forming methods
5. Explains the simple micro machining processes

Unit No.	Syllabus	No.of hours
1.	**Finishing And Superfinishing Process - Broaching Process** Principle of broaching. Details of a broach. Types of broaching machines-constructional details. Applications. Advantages and Limitations. Finishing and other Processes Lapping and Honing operations – Principles, arrangement of set up and application. Super finishing process, polishing, buffing and application	06
2.	**NON-TRADITIONAL MACHINING PROCESSES** Need for nontraditional machining, Principle, equipment & operation of Laser Beam, Plasma Arc Machining, Electro Chemical Machining, Ultrasonic Machining, Abrasive Jet Machining, Water Jet Machining, Electron Beam Machining, Electron Discharge Machining and Plasma Arc Machining.	07
3.	**NON-TRADITIONAL MACHINING PROCESSES** Definition, Principles, Classification, Application, Advantages & limitations of welding. Arc Welding: Principle, Metal Arc welding (MAW), Flux Shielded Metal Arc Welding (FSMAW), Inert Gas Welding (TIG & MIG). **RESISTANCE WELDING:** Principles, Friction stir welding process, Laser beam welding, Ultrasonic welding. **PRINCIPLES OF SOLDERING & BRAZING:** Parameters involved & Mechanism. Different Types of Soldering & Brazing Methods.	07

4.	**METAL FORMING** Forming methods, dies & punches, progressive die, compound die, combination die. Rubber forming, Open back inclinable press (OBI press), piercing, blanking, bending, deep drawing, Types of extrusion processes, extrusion equipment, Extrusion dies, Extrusion of seamless tubes. Extrusion variables, simple problems, piercing, blanking, bending, deep drawing, LDR in drawing, Classification of Rolling processes. Types of rolling mills, expression for Rolling load. Roll separating force, Rolling variables, simple problems.	10
5.	**Micromachining** Micro Machining Processes-An introduction, Molecular Dynamic Simulation of Machining at the Atomic Scale, Diamond Turn Machining, Abrasive Jet Micro Machining, Magneto-Rheological Nano finishing processes,	06

TEXT BOOKS :

1.“Manufacturing Process-I”, Dr. K. Radhakrishna, Sapna Book House, 5th Re-vised Edition 2009.

2.“Manufacturing & Technology: Foundry Forming and Welding”, P.N. Rao 2nd Ed., Tata McGraw Hill, 2003.

3.Manufacturing Science, AmitabhaGhosh and Mallik, affiliated East West Press, 2005.

4.Manufacturing Process – III, Dr. K.Radhakrishna, SapnaBook House, 2009.

REFERENCE BOOKS:

1. “Manufacturing Technology”, SeropeKalpakjain, Steuen.R. Sechmid, Pearson Education Asia, 5th Ed. 2006.

2. “Process and Materials of Manufacturing”, Roy A Lindberg, 4th Ed. Pearson Edu. 2006.

3. V.K.Jain, “Introduction to Micro Machining”

4. Narosa, 2010 JosephMc Geough, “Micro machining of Engineering Materials”

5. Principles of Metal Casting”, Rosenthal, Tata McGraw Hill Publications.

6. Mechanical Metallurgy – Dieter, Tata McGraw Hill, 2001.

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven Full Questions to be set and Five full Questions to be answered.

2. Unit-1, Unit-2 and Unit-5 are compulsory, with one question from each Unit and from Unit-3 and Unit-4: Two questions to be set with choice

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	1	0	2	0	3	0	0	0	1	0	0	2
2	2	1	2	3	3	0	3	1	1	0	0	2
3	2	0	3	2	3	3	2	0	2	1	0	2
4	2	1	2	3	1	1	2	1	1	0	0	1
5	2	1	3	3	3	2	2	1	2	0	0	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : POWER PLANT ENGINEERING (CORE ELECTIVE)		
Course Code : ME553	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/ week : 03
Exam Duration: 3 Hrs		Exam Marks : 100
	Basic Thermodynamics, Fluid Mechanics, Turbo Machines	

Course objectives:

1. To familiarize with different conventional and non-conventional energy sources.
2. To demonstrate layout and components of Steam power plants, Diesel engine power plants, Hydroelectric power plants, Nuclear power plants
3. To implement principles of power generation through solar energy, Wind energy Ocean, Tidal energy & Fuel cells.
4. To apply basic calculations to understand design principles of conventional en-ergy conversion.
5. To demonstrate competence in understanding performance of energy conversion devices through experiments.

Unit No.	Syllabus	No.of hours
1.	**THERMAL POWER PLANTS** Introduction: Energy sources for generation of electric power, energy policy of India, present status and future trends, major power plants in India. Thermal Power Plants: Selection of site, general layout of the plant, major components- Boilers, Economizers, Super-heaters, Air pre-heaters, fuels, fuel and ash handling equipment, High pressure Boilers, steam turbines, station heat balance and plant efficiency	07
2.	**DIESEL ENGINE POWER PLANT** Introduction; Applications of Diesel Engines in power field, Advantages and disadvantages diesel engine power plant, Types, General layout, Combustion in a CI engine, Performance characteristics, Supercharging, Layout of diesel engine power plant, Numericals.	06
3.	**HYDROELECTRIC POWER PLANTS** Introduction; Classification of hydro-plants, selection of site, rain fall and run off, calculation of storage capacity, plant layout, estimation of power available, selection of hydraulic turbines and their governing, general layout of hydro power plant	06
4.	**NUCLEAR POWER PLANT** Nuclear Power Plants: Introduction, Atomic structure and radio-activities nuclear reactions, binding energy, Nuclear Reactors,	10

	Types of reactors, Pressurized water reactors, boiling heater reactors, Heavy water-cooled and moderated (CANDU) reactor, Gascooled reactors, Liquid metal cooled reactors, Indian Nuclear power installations, comparison between Nuclear and Thermal plants, Numericals	
5.	**NON CONVENTIONAL POWER GENERATION** Introduction, Direct energy conversion, MHD, Thermiconic and Thermoelectric power generation, Fuel cells, Geothermal energy, Hydrogen energy systems, Numericals	**10**

TEXT BOOKS

1. Power Plant Engineering, P. K. Nag, Tata McGraw Hill , 4thEdition, 2014.

2. A Text Book of Power Plant Engineering, R. K. Rajput, Laxmi publication, New Delhi, 4th Edition, 2007.

REFERENCE BOOKS

1. Power Plant Engineering, G.R. Nagpal and S.C. Sharma, Khanna Publishers,16th Edition, 2012.

SYLLABUS COVERAGE FOR CIE

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)
CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit 1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES: On completion of the course, student should be able to; After completion of the course, students will be able to:

1. Recognize different conventional and non-conventional energy sources.

2.Describe the layout and components of Steam power plants, Diesel engine power plants, Hydroelectric power plants, Nuclear power plants

3. Explain principles of power generation through Solar energy, Wind energy, Ocean, Tidal energy and Fuel cells.

4. Apply basic calculations to understand design principles of conventional and non-conventional energy conversion.

5. Compare advantages & limitations of conventional and non-conventional energy sources.

6. Demonstrate competence in understanding performance of energy conversion devices through experiments.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : THEORY OF ELASTICITY (CORE ELECTIVE)		
Course Code : ME561	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/ week : 03
Exam Duration: 3 Hrs		Exam Marks : 100

Course objectives:

1. To study the basic concept of stresses, stress distribution, elastic constants when the material is subjected to loading within the elastic limits

2. Study the stress distribution in plane, polar and cylindrical coordinate systems

3. Analyze the material or component subjected to torsion of circular and non-circular shafts (elliptical, triangular bars)

Unit No.	Syllabus	No.of hours
1.	**DEFINITION AND NOTATION** Stress, Stress at a Point, Equilibrium Equations, Principal Stresses, Mohr's Diagram, Maximum Shear Stress, Boundary Conditions. **STRAIN AT A POINT:** Compatibility Equations, Principal Strains, Generalised Hooke's law, Methods of Solution of Elasticity Problems – Plane Stress-Plane Strain Problems. **UNIQUENESS THEOREM:** Principle of super position, reciprocal theorem, saint venant principle. And make it with internal choice	10
2.	**TWO DIMENSIONAL PROBLEMS** Cartesian co-ordinates – Airy's stress functions – Investigation of Airy's Stress function for simple beam problems – Bending of a narrow cantilever beam of rectangular cross section under edge load – method of Fourier analysis – pin ended beam under uniform pressure	07
3.	**STRESSES IN AN INFINITE PLATE** (with a circular hole) subjected to uniaxial and biaxial loads, stress concentration, stresses in rotating discs and cylinders. **GENERAL EQUATIONS IN CYLINDRICAL CO-ORDINATES:** Thick cylinder under uniform internal and / or external pressure, shrink and force fit, stress concentration	10
4.	**THERMAL STRESSES** Thermo elastic stress strain relationship, Equations of equilibrium Thermal stresses in thin circular discs and in long circular cylinder, sphere. **TORSION OF CIRCULAR, ELLIPTICAL AND TRIANGULAR BARS:** membrane analogy, torsion of thin open sections and thin tubes	07
5.	**UNIQUENESS THEOREM** Principle of super position, reciprocal theorem, saint venant principle	05

COURSE OUTCOMES:

1. Make the students to understand the concept of elastic and plastic behavior of the material
2. Analyze the stress and strain tensors at a point in a member subjected to loading (point/distributed)
3. Applying the concept of compatibility and equilibrium conditions to analyze the stress and strain tensors
4. Study the thermo-elastic properties of the material at elevated temperatures
5. Analyzing the stress concentration factor of a structural component subjected to different types of load
6. Analyzing the different types of uniqueness theorems

TEXT BOOKS:

1. Advanced Mechanics of solids, L. S. Srinath, Tata Mc. Graw Hill, 2003

2. Theory of Elasticity, S. P. Timoshenko and J. N Gordier, Mc.Graw Hill International, 3rd edition, 1972

REFERENCES BOOKS:

1. Theory of Elasticity, Dr. Sadhu Singh, Khanna Publications, 1988

2. Elasticity, Theory, Applications &Numericals, Martin H Sadd, Elsevier. 2005

3. Applied Elasticity, Seetharamu&Govindaraju, Interline Publishing

4. Applied Elasticity, C.T. WANG Sc. D. Mc. Graw Hill Book Co.1953.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven Full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-4 and Unit-5 are compulsory, with one question from each Unit.
4. Unit-1 and Unit-3: Two questions to be set with choice.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	2	2	0	1	0	1	0	3	1	3	0
2	2	3	2	2	1	0	1	0	3	1	3	0
3	3	3	2	1	3	0	1	0	3	2	3	2
4	0	1	2	1	3	1	2	0	2	2	2	2
5	0	0	0	2	2	1	2	1	2	1	2	2
6	0	3	0	1	1	0	0	0	1	2	2	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : COMPOSITE MATERIALS AND MANUFACTURING(CORE ELECTIVE)		
Course Code : ME562	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/ week : 03
Exam Duration: 3 Hrs		Exam Marks : 100

Course objectives:

1. Understand capabilities and limitations of existing materials and processes.
2. Define property enhancement mechanisms.
3. To understand the fundamentals of composite material strength and its mechanical behavior
4. Understanding the analysis of fiber reinforced Laminate design for different combinations of plies with different orientations of the fiber.
5. Determine opportunities for improvement.
6. Select materials and processes to best suit specific applications.
7. To develop knowledge on processing, interfacial properties and application of composites
8. An ability to predict the elastic properties of both long and short fiber composites based on the constituent properties.

Unit No.	Syllabus	No.of hours
1.	**INTRODUCTION** General introduction to composites; historical background; concept of matrix and reinforcement and particulate. **MATRIX AND REINFORCEMENT** Types of matrix and reinforcement, volume fraction and weight fraction Fiber architecture fiber packing arrangements, whiskers	07
2.	**FABRICATION METHODS OF POLYMER COMPOSITES** Liquid resin impregnated routes, pressurized consolidation of resin pre-pegs, consolidation of resin molding compounds, injection molding of thermoplastics, hot press molding of thermoplastics.	06
3.	**FABRICATION OF CERAMIC COMPOSITES** Powder based routes, reactive processing, layered ceramic composites, carbon/carbon composites, **FABRICATION ROUTES OF METAL MATRIX COMPOSITES** Squeeze infiltration, stir casting, spray deposition, powder blending and consolidation, diffusion bonding of foils, PVD	10
4.	**TESTING AND CHARACTERIZATION** Different tests like internal stress measurement by diffraction, metallographic preparation etc with special emphasis to metal matrix composites	10

	SECONDARY PROCESSING AND APPLICATION OF COMPOSITES Secondary processing like machining, joining, extrusion of composites; Application and case studies	
5.	**SMART MATERIALS** Introduction and properties of piezoelectric materials, shape memory alloys, ER and MR fluids, electrostrictive and magntostrictive materials as smart materials, applications	**06**

COURSE OUTCOMES: On completion of the course, student should be able to;

1. To study matrix material, particulates and fibres of polymer matrix composites, MMC and ceramic matrix composites.

2. An ability to identify the properties of fiber and matrix materials used in commercial composites, as well as some common manufacturing techniques.

3. An understanding of how composites are used in the design of structures and Understand composite material and processing requirements for optimizing composite performance.

4. An ability to understand and select suitable processes for fiber reinforced, metal matrix composites and ceramic composites.

5. An ability to test and characterize the composites with more emphasis metal matrix composites.

6. An ability to process composites through secondary processing techniques such as machining, joining and extrusion.

TEXT BOOKS:

1. S.C.Sharma Composite materials Narosa Publishers

REFERENCE BOOKS:

1. R.K.Everret& R.J. Arsenault Metal matrix composite Academic press
2. T. W. Clyne& P. J. Withers Introduction to metal Matrix Composite Cambridge press

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-2 and Unit-5 are compulsory, with one full question from each Unit.
4. Unit-3 and Unit-4: Two full questions to be set with choice

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : HEATING, VENTILATION AND AIR CONDITIONING (CORE ELECTIVE)		
Course Code : ME563	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/ week : 03
Exam Duration: 3 Hrs		Exam Marks : 100
Pre-requisites	Basic & Applied Thermodynamics, Heat Transfer, Refrigeration	

Course Objectives:

1. To understand concept of Psychrometry and explain various air conditioning processes.

2. To explain design conditions for human comfort and critical loading conditions.

3. To calculate the various cooling loads to select the air conditioning apparatus..

4. To understand the various heat sources for optimal design of dehumidifying coils and another air conditioning apparatus.

5. To design the air ducts for proper ventilation and distribution of clean air through the airc conditioned space.

Unit No.	Syllabus	No.of hours
1.	**PSYCHROMETRY** Introduction to air conditioning: Brief history, Working substance, Psychrometric properties, Wet bulb temperature, Adiabatic satu-ration, Psychrometric chart, Application of I law to Psychrometric process; Psychrometry of air conditioning processes – Mixing pro-cess, Basic processes, Psychrometric processes in air condition-ing equipment, Simple air conditioning, Summer and winter air conditioning system, Apparatus Dew Point, Numericals	06
2.	**DESIGN CONDITIONS** Introduction; Choice of inside design conditions, Comfort, Outside design conditions, Choice of supply design conditions, Critical loading conditions, Clean spaces; Heat transfer through building structures, Overall heat-transmission coefficient, Empirical methods to evaluate heat transfer through walls and roofs, Natural ventilation through infiltration, Passive heating and cooling of buildings, Water vapour transfer through structures, Numericals.	06
3.	**LOAD CALCULATIONS** Introduction; Preliminary considerations, Internal heat gains, System heat gains, Break-up of ventilation load and effective sensible heat factor, Cooling load and heating load estimate, Psychrometric calculations for cooling, Selection of air conditioning apparatus for cooling and dehumidification, evaporative cooling, Building requirements and energy conservation in air conditioned buildings, Numericals	07

4.	**DESIGN OF AIR CONDITIONING APPARATUS** Introduction: Heating systems – warm air systems – hot water systems – steam heating systems – panel and central heating systems, Heat pump circuit, Heat sources for heat pump. Air conditioning apparatus, Heat and moisture transfer, Design of cooling and dehumidifying coils, Optimal design, Design of air washers and cooling towers, Numericals	10
5.	**TRANSMISSION AND DISTRIBUTION OF AIR** Introduction: Room air distribution, Total, static and velocity pressures, Friction and dynamic loss in ducts, Air flow through simple duct system, Air-duct design, Processing, transmission and distribution of air in clean rooms, Air locks, Air curtains and Air showers, Numericals	10

TEXT BOOKS:

1. Refrigeration and Air Conditioning, C.P. Arora, McGraw-Hill Education (In-dia) Pvt. Limited, 3rd Edition, 2009.

2. Refrigeration and Air Conditioning, Manohar Prasad, New Age International (P) Limited Publishers, 3rd Edition, 2015.

REFERENCE BOOKS

1. Hand Book Air Conditioning and Refrigeration, Shan K Wang, 2ndEdition, McGraw-Hill Publications, 2000.

2. Refrigeration and Air Conditioning, W.F. Stoecker, and J.W. Jones, 2ndEdi-tion, Tata McGraw-Hill Publications, 1982.

3. ASHRAE Handbook- Fundamentals, American Society of Heating, Refrigerating and Air-Conditioning, Engineers Inc., Atlanta, USA, 1997.

DATA HAND BOOKS AND CHARTS

1. Refrigeration Tables and Charts: SI Units, C.P. Kothandaraman**,** 4thEdition,New Age International Publishers, 2015.

SYLLABUS COVERAGE FOR CIE

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)

CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.

2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.

3. Each question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Describe the properties of moist air, design conditions and load calculations for heating, ventilation and air conditioning purposes.

2. Distinguish the various air conditioning system and heat gains, used in the design conditions.

3. Solve problems related to application of various air conditioning apparatus and transmission and distribution of air.

4. Analyse the design conditions and load calculations for the given air conditioning apparatus.

5. Derive mathematical expressions and equations to determine the various design and load parameters in designing the air conditioning equipment.

6. Calculate the Psychrometric properties, critical loading conditions, system heat gains, air flow rates in various air conditioning equipment.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : HEAT TRANSFER LABORATORY		
Course Code : MEL57	No of Credits : L-T-P-SS 00:00:02:00 =01	No. of lecture hours/ week : 02
Exam Duration: 3 Hrs		Exam Marks : 50
	Basic Thermodynamics, Fluid Mechanics, Heat Transfer	

Course objectives:

1. To understand the basic conduction, convection and radiation heat transfers.
2. To study combined conduction and convection states of heat transfer.
3. To determine emissivity of a grey body and verify Stefan Boltzmann constant.
4. To determine effectiveness of parallel flow and counter flow heat exchangers.
5. To conduct tests on vapor compression refrigeration.

Unit No.	Syllabus	No.of hours
1.	**MINOR EXPERIMENT** 1. Composite wall - Determination of overall heat transfer coefficient of a composite wall. 2. Metal rod - Determination of thermal conductivity of a metalrod. 3. Fin – Determination of efficiency and effectiveness of a fin free convection mode. 4. Emissivity - Determination of emissivity of a given grey sur-face	10
2.	**MAJOR EXPERIMENT** 1. Vertical pipe - Determination of heat transfer coefficient in free convection mode. 2. Pipe flow - Determination of heat transfer coefficient in forced convection mode for hot air flowing through a circular pipe. 3. Stefan Boltzmann constant - Verification of Stefan Boltzmann Constant. 4. Fin - Determination of efficiency and effectiveness of a fin in forced convection mode. 5. Shell and Tube heat exchanger - Determination of Log Mean Temperature Difference (LMTD) and Effectiveness in (i) Par-allel Flow mode and (ii) Counter Flow mode 6. Vapour Compression Refrigerator (VCR) – Determination of COP.	10

REFERENCE BOOKS

1. Heat and Mass Transfer, P.K. Nag, 3rd Edition, Tata McGraw-Hill, 2011.

2. A Course in Heat and Mass Transfer, Domkundwar, Arora, Domkundwar, DhanpatRai Publications, 2005.

3. Basic and Applied Thermodynamics, P.K. Nag, Tata McGraw-Hill Publica-tions, 2nd Edition, 2010.

SCHEME OF EXAMINATION (SEE)

SI. No.	Particulars	Max. Marks	Break Up of Max. Marks		
			Write Up	Conduction of experiment	Specimen Calculation, Tabulation of Results and Plotting of Graph
1.	**Unit-1: Minor Experiment** (Any ONE from the list of experiments)	15	05	05	05
2.	**Unit-2: Major Experiment** (Any ONE from the list of experiments)	25	05	10	10
3.	**Viva Voce**	10	-	-	-
		50	10	25	15

COURSE OUTCOMES: On completion of the course, student should be able to;After completion of the course, students will be able to:

1. Identify the equipment used for illustrating various modes of heat transfer.
2. Explain the various modes of heat transfer and heat transfer devices with ex-amples and illustrations.
3. Demonstrate the working of equipment used in the laboratory.
4. Illustrate the procedure used to conduct the experiment with equipment.
5. Analyse the expressions to determine the heat transfer rate from various modes of heat transfer.
6. Calculate the rate of heat transfer in different equipment and plot the results of various heat transfer systems.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : FUEL TESTING AND INTERNAL COMBUSTION ENGINES LABORATORY		
Course Code : MEL58	No of Credits : L-T-P-SS 00:00:02:00 =01	No. of lecture hours/ week : 02
Exam Duration: 3 Hrs		Exam Marks : 50
	Basic & Applied Thermodynamics, Heat Transfer	

Course objectives:

1. To conduct tests on oils to determine flash, fire points and viscosity.
2. To determine calorific value of a given fuel.
3. To plot the valve timing diagram of 2-stroke and 4-stroke IC engine.
4. To calculate the area of an irregular shape using planimenter.
5. To conduct performance test on petrol and diesel IC engine and evaluate the power produced and efficiencies.
6. To conduct Morse test on 4-stroke multi cylinder engine to determine the utility of heat input and draw heat balance sheet.

Unit No.	Syllabus	No.of hours
1.	**MINOR EXPERIMENT** 1. Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Martin (closed) / Cleaveland (Open Cup) Apparatus. 2. Determination of Calorific value of solid, liquid and gaseousfuels. 3. Determination of Viscosity of lubricating oil using Redwoods, Saybolts and Torsion Viscometers. 4. Valve Timing/port opening diagram of an I.C. engine (4 stroke/ 2 stroke). 5. Use of planimeter.	10
2.	**MAJOR EXPERIMENT** Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal efficiencies, SFC, FP, heat balance sheet for ☐ Four stroke Diesel Engine ☐ Four stroke Petrol Engine ☐ Two stroke Petrol Engine ☐ Multi Cylinder Diesel/Petrol Engine, (Morse test)	16

REFERENCE BOOKS

1. Basic and Applied Thermodynamics, P.K. Nag, Tata McGraw-Hill Publica-tions, 2ndEdition, 2010.

SCHEME OF EXAMINATION (SEE)

SI. No.	Particulars	Max. Marks	Break Up of Max. Marks		
			Write Up	Conduction of experiment	Specimen Calculation, Tabulation of Results and Plotting of Graph
1.	**Unit-1: Minor Experiment** (Any ONE from the list of experiments)	15	05	05	05
2.	**Unit-2: Major Experiment** (Any ONE from the list of experiments)	25	05	10	10
3.	**Viva Voce**	10	-	-	-
		50	10	25	15

COURSE OUTCOMES: On completion of the course, student should be able to; After completion of the course, students will be able to:

1. Conduct basic tests on lubricating oil like fire, flash, cloud and pour points along with viscosity.
2. Determine calorific values of all types of fuels.
3. Plot internal combustion engine valve timing diagrams.
4. Calculate the area of irregular shapes using planimeter.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

AIT/Dean/ /2016-17

Dr Ambedkar Institute of Technology, Bengaluru
(An Autonomous Institution Affiliated to VTU, Belgavi)
INTER-DEPARTMENTAL ELECTIVES 2017-18

Sl No	Subject Title	Subject Code	Prerequisite	Depts. For which the course can be offered	Room No	Teaching Dept	No of section
1	Integrated Solid Waste Management	CVE01	Environmental science	All Dept	S108	CV	01
2	Elements of Operations research	MEE01	NIL	All Dept		ME	02
3	Elements of Solar Engineering	MEE02	NIL	All Dept		ME	02
4	Elements of Power plant Engg.,	MEE03	NIL	All Dept		ME	02
5	Product Design and Development	MEE04	NIL	All Dept		ME	01
6	Renewable Energy Sources	EEE01	NIL	All Dept	S110	EE	01
7	Cryptography	ECE01	NIL	CS,IS,TC,EE,EI	C203	ECE	01
8	Automotive Safety Measurements	ECE02	NIL	CS,IS,TC,EE,EI,ME	C209	ECE	01
9	Internet Engineering	TEE01	Computer Networks	CS,IS,EC,EE,EI,ML	C322	TCE	01
10	RTOS	TEE02	NIL	CS,IS,EC,EE,EI,ML	C405	TEC	02
11	Arm Processor	ITE01	Microcontroller	EC,EE,ML,TE,	C404	IT	01
12	Wireless Sensor Networks	CSE01	Basic of Computer N/W	TE,EC,IS,IT	C116 / C119	CSE	01
13	Storage Area Network	CSE02	Basic of Computer N/W	TC, EC,IS,IT	C116 / C119	CSE	01
14	Unix Shell Programming	CSE03	Basic of Computer Language	TC,EC,IS,IT,EE,ME, CV,ML,IEM	C116 / C119	CSE	01
15	Information Systems	ISE02	Computer Fundamentals	CS,EC,EE,ML,TC,IT	D109	ISE	01
16	Medical Imaging Systems	MEL01	NIL	All Dept	302A	ML	01
17	Neural Networks	MEL02	NIL	All Dept	302A	ML	01
18	Engineering Economy	IME01	NIL	All Dept	322A	IEM	01

Dean (Academic) Principal

Copy to 1. Principal W/cs for information
2. All HODs

VI Semester (2015-16)

COURSE TITLE : DESIGN OF MACHINE ELEMENTS – II		
Course Code : ME61	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/ week : 04
Exam Duration: 3 Hrs		Exam Marks : 100

Course objectives:

This course "Design of Machine Elements -II" After clearly understand the design-I – COURSE further he has to learn various other machine components with the following objectives in mind:

1.The student shall gain appreciation and understanding straight and curved beams and general applications of curved beams such as machine frame, punching machine and crane hook, bending and resultant stress occurs at various sym-metrical and non-symmetrical crass sections and extended chain links used for curved beams.

2.The student shall be able to understand functions of various spring and its application, types of springs, such as helical, spiral, buffer, conentric and leaf springs and stress induced, deflection, energy stored in the spring, design procedure, selection of suitable material to design and design springs for various suitable applications.

3. The student shall be able to understand meaning of gear drive importance of gear drive, various fields of applications, general classifications, general characteristics, requirements of gear drive, types of tooth profile ,loads, selection of suitable material for gear design stress acting on gears and design procedure to design a different gears for various applications,

4. The student shall be able to understand functions of lubrications, desirable properties, types of lubrications system, selection proper grade of lubrication for par-ticular application, and also to understand functions of bearing, general classification, design procedure to design any bearing, selection of various factors for bearings, determination of life of bearing, selection of proper grade of lubrication suitable and heat generated, heat dissipated etc.

Unit No.	Syllabus	No.of hours
1.	**CURVED BEAMS** Stresses in curved beams of standard cross sections used in crane hook, punching presses & clamps, closed rings and links	08
2.	**SPRINGS** Introduction, classification of springs stresses in helical coil springs of circular sections, Energy stored in springs, and problems on helical coil springs., Concentric springs, advantages and applications and design of concentric springs under fluctuating loads, Leaf Springs, advantages and applications, classifications: Stresses in leaf springs. Equalized stresses in springs.	12

3.	**SPUR& HELICAL GEARS** **SPUR GEARS**: Introduction ,classification, advantage, disadvantages and applications, terminology of spur gears, material selection for spur gear design, stresses in gear tooth: Lewis equation and form factor, Design for strength, Dynamic load and wear load., problems on spur gear **HELICAL GEARS:** Bevel Gears: Introduction ,classification, advantage, dis-advan-tages and applications, terminology of helical gears, formative number of teeth, material selection for helical gear design, stresses in gear tooth: Lewis equation and form factor, Design for strength, Dynamic load and wear load., problems on helical gear.	08
4.	**BEVEL AND WORM GEARS BEVEL GEARS**: Introduction, classification, advantage, applications, terminology of bevel gears, formative number of teeth, material selection for bevel gear design, stresses in gear tooth: Lewis equation and form factor, Design for strength, Dynamic load and wear load., problems on bevel gear. **WORM GEARS**: Introduction, classification, advantage, applications, terminology of bevel gears, formative number of teeth, material selection for worm gear design, stresses in gear tooth: Lewis equation, Design for strength, Dynamic load and wear loads and efficiency of worm gear drives and problems on worm gears	10
5.	**LUBRICATION& BEARINGS** **LUBRICATION** Lubricants and their properties, Classification of bearings, Mecha-nisms of Lubrication bearing modulus, coefficient of friction, mini-mum oil film thickness, Heat generated, Heat dissipated. **BEARINGS:** Classification, Bearing Materials, Examples of journal bearing and thrust bearings, selection of ball bearing and journal bearing.	10

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Define basic concepts of vibration of bodies having one, two and multi degree freedom Develop basic mathematical models and Estimate natural frequency of mechanical element/system for undamped and damped mechanical SDOF systems.

2. Discuss equations of motion Analyze vibratory response of mechanical element/ system for free un damped and damped and forced vibration respons and estimate the parameters of vibration isolation systems for industrial environment.

3. Ability to find vibration parameters numerically by 2-degree and multi degree freedom by various numerical techniques

4. Explore modern vibration measuring instruments. Condition monitoring of working machineries

TEXT BOOKS

1. Mechanical Engineering Design, Joseph E Shigley and Charles R. Mischke. McGraw Hill International edition, 6th Edition 2003.

2. Design of Machine Elements, V. B Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2007.

REFERENCE BOOKS

1. Machine Design, Robert L. Norton, Pearson Education Asia, 2001.

2. Design of Machine Elements, M. F. Spotts, T. E. Shoup, L. E. Hornberger, S. R. Jayram and C. V. Venkatesh, Pearson Education, 2006.

3. Machine Design, Hall, Holowenko, Laughlin (Schaum's Outlines series) Adapted by S.K. Somani, Tata McGraw Hill Publishing Company Ltd., New Delhi, Special Indian Edition, 2008.

4. Machine Design, A CAD Approach: Andrew D DIMAROGONAS, John Wiley Sons, Inc, 2001.

DESIGN DATA HANDBOOK

1. Design Data Hand Book , K. Lingaiah, McGraw Hill, 2ndEdition.

2. Data Hand Book, K. Mahadevan and Balaveera Reddy, CBS Publication

3. Design Data Hand Book, H.G. Patil, ShriShashiPrakashan, Belgaum.

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven Full Questions to be set and Five full Questions to be answered.
2. Unit-1, Unit-4 and Unit-5 are compulsory, with one question from each Unit.
3. Unit-2 and Unit-3: Two questions to be set with choice.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)

CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs /POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	3	3	2	3	1	3	2
CO2	3	3	3	2	1	3	3	1	2	2	3	2
CO3	3	3	2	3	3	0	1	3	3	2	3	2
CO4	3	3	1	3	3	3	3	2	1	3	2	3

High 3 **Medium 2** **Low 1**

COURSE TITLE : FINITE ELEMENT METHODS		
Course Code : ME62	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/ week : 04
Exam Duration: 3 Hrs		Exam Marks : 100

Course Objectives:

1. To impart structures analysis for stress, strain & dynamic loading knowledge
2. To enable formulation of the design problems into FEA.
3. To comprehend the basic concepts and enhance capabilities for solving complex problems.
4. To introduce the concepts of elastic and static analysis problems.

Unit No.	Syllabus	No.of hours
1.	**INTRODUCTION** Equilibrium equations in elasticity subjected to body force, traction forces, and stress-strain relations for plane stress and plane strains. General description of Finite Element Method, Application and limitations. Types of elements based on geometry. Node numbering, Half band width. **BASIC PROCEDURE**: Euler - Langrange equation for bar, beam (cantilever / simply supported fixed) Principle of virtual work, principle of minimum potential energy, Raleigh's Ritz method. Direct approach for stiffness matrix formulation of bar element.Galerkin's method.	**08**
2.	**INTERPOLATION MODELS** Interpolation polynomials- Linear, quadratic and cubic.Simplex complex and multiplex elements.2D PASCAL's triangle. CST elements-Shape functions and Nodal load vector, Strain displacement matrix and Jacobian for triangular and rectangular element. **SOLUTION OF 1-DIMENSIONAL BARS:** Solutions of bars and stepped bars for displacements, reactions and stresses by using penalty approach and elimination approach. Guass-elimination technique.	**12**
3.	**HIGHER ORDER ELEMENTS** Lagrange's interpolation, Higher order one dimensional elements-Quadratic and cubic element and their shape functions. Shape function of 2-D quadrilateral element-linear, quadric element Iso-parametric, Sub parametric and Super parametric elements. Numerical integration : 1, 2 and 3 gauge point for 1D and 2D cases.	**10**

4.	**TRUSSES** Stiffness matrix of Truss element.Numerical problems	**10**
5.	**BEAMS** Hermite shape functions for beam element, Derivation of stiffness matrix. Numerical problems of beams carrying concentrated, UDL and linearly varying loads	**12**

COURSE OUTCOMES: On completion of the course, student should be able to;

1. To teach the students about the concepts of FEM and FEA.
2. Develop the knowledge to analyse structures under static and dynamic condi-tions.
3. Identify the numerical techniques for solving engineering problems using FEM.
4. Identify types of elements such as higher order, beams , trusses for different applications.

TEXT BOOKS:

1. Finite Elements in Engineering, T.R.Chandrupatla, A.D Belegunde, 3rd Ed PHI.

2. Finite Element Method in Engineering, S.S. Rao, 4th Edition, Elsevier, 2006.

REFERENCE BOOKS:

1. "Finite Element Methods for Engineers" U.S. Dixit, Cengage Learning, 2009.

2. Concepts and applications of Finite Element Analysis, R.D. Cook D.S Maltus, M.E Plesha, R.J.Witt, Wiley 4th Ed, 2009

3. Finite Element Methods, Daryl. L. Logon, Thomson Learning 3rd edition, 2001.

4. Finite Element Method, J.N. Reddy, McGraw -Hill International Edition.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven Full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-3 and Unit-4 are compulsory, with one question from each Unit.
4. Unit-2 and Unit-5: Two questions to be set with choice.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : MECHANICAL VIBRATIONS		
Course Code : ME63	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/ week : 04
Exam Duration: 3 Hrs		Exam Marks : 100

Course Objectives:

1. To observe, analyze and understand the concept of vibrations in mechanical systems, various technique to solve single degree freedom and single dof without damping with damping, 2-degree, forced vibration and, determine Estimate natural frequency of me-chanical system multi degree freedom system using various numerical techinques.

2. To comprehend the fundamentals of vibration theory types of vibrations and

3. To recognize how to apply theory of vibration to engineering problems.

4. To be able to mathematically formulate real-world vibration problems in engineering

Unit No.	Syllabus	No.of hours
1.	**INTRODUCTION** Types of vibration, Definitions, Simple Harmonic Motion (S.H.M.), Work done by harmonic force, Principle of super position applied to SHM, Beats. **UNDAMPED FREE VIBRATIONS** Classic spring mass systems of single degree of freedom, Different methods of determination of natural frequencies of simple systems, Springs in series and parallel, Torsional and transverse vibrations, Effect of mass of spring	08
2.	**DAMPED FREE VIBRATIONS** Types of damping**,** Analysis with viscous damping - Derivations for overdamped, critically damped and under damped systems, Logarithmic decrement and numericals. Whirling of shafts with and without damping, speed discussion below and above critical speeds, Numericals	12
3.	**FORCED VIBRATIONS** Introduction**,** Analysis of forced vibration with constant harmonic excitation - magnification factor, rotating and reciprocating unbal-ances, support excitation for relative and absolute amplitudes, force and motion transmissibility. **VIBRATION MEASURING INSTRUMENTS:** Introduction to Vibrometers, Accelerometer, Frequency measuring instruments	14
4.	**SYSTEMS WITH TWO DEGREES OF FREEDOM** Principle modes and normal modes of vibrations, natural frequencies of systems (without damping) – Simple spring mass systems, torsional systems, combined rectilinear and angular systems, geared semi-defined systems, semi-definite systems and numericals. Dynamic vibration absorber.	08
5.	**NUMERICAL METHODS FOR MULTI DEGREE FREEDOM OF SYSTEMS** Introduction, Maxwell's reciprocal theorem, Influence coefficients, Rayleigh's method, Dunkerley'smethod.Problems on Stodola method and Holzer's methods only.Orthogonality of principal modes; Introduction to Modal analysis and Condition Monitoring	10

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Define basic concepts of vibration of bodies having one, two and multi degree freedom Develop basic mathematical models and Estimate natural frequency of mechanical element/system for undamped and damped mechanical SDOF sys-tems.

2. Discuss equations of motion Analyze vibratory response of mechanical element/ system for free un damped and damped and forced vibration respons and estimate the parameters of vibration isolation systems for industrial environment.

3. Ability to find vibration parameters numerically by 2-degree and multi degree freedom by various numerical techniques

4. Explore modern vibration measuring instruments. Condition monitoring of working machineries

TEXT BOOKS:

1. Mechanical Vibrations, G. K.Grover, Nem Chand and Bros, 7th edition, 2003.

2. Mechanical Vibrations, S. S. Rao, Pearson Education Inc, 4th edition, 2003.

3. Mechanical Vibrations, V. P. Singh, DhanpatRai& Company, 3rd edition, 2006.

REFERENCE BOOKS:

1. Theory of Vibration with Applications, W. T. Thomson, M. D. Dahleh and C.Padmanabhan, Pearson Education Inc, 5th edition, 2008.

2. Mechanical Vibrations: S. Graham Kelly, Schaum's outline Series, Tata McGrawHill, Special Indian Edition, 2007.

3. Theory and Practice of Mechanical Vibrations: J. S. Rao& K. Gupta, NewAge International Publications, New Delhi, 2001.

4.Vibration Fundamentals, R. Keith Mobley, Newness, 1999.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven Full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-4 and Unit-5 are compulsory, with one question from each Unit.
4. Unit-2 and Unit-3: Two questions to be set with choice.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	2	2	3	3	2	3	3	1	2
2	2	3	3	2	2	1	3	2	3	3	3	2
3	3	3	3	2	3	2	3	1	3	2	3	2
4	3	3	2	2	3	2	3	1	2	2	3	3

Strong-3, Medium-2, Weak-1

COURSE TITLE : OPERATIONS RESEARCH		
Course Code : ME64	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/ week : 04
Exam Duration: 3 Hrs		Exam Marks : 100

Course Objectives:

1. Explain the historical development of OR and its areas of applications.
2. Formulate the mathematical model of managerial problems like product mix etc.
3. Solve the problems where the variables are linear in nature by graphical method and simplex method.
4. Formulate and solve balanced and unbalanced Transportation problems.
5. Formulate and solve assignment problem.
6. Draw the project network diagram and schedule the project.
7. Analyze queuing system and find its parameters.
8. Formulate two person-zero sum game.
9. Find the best strategy for the given game by graphical and dominance methods

Unit No.	Syllabus	No.of hours
1.	**INTRODUCTION** Evolution of OR, definition of OR, scope of OR, application areas of OR, steps (phases) in OR study, characteristics and limitations of OR, models used in OR, linear programming (LP) problem-formulation and solution by graphical method. **SOLUTION OF LINEAR PROGRAMMING PROBLEMS**: The simplex method-canonical and standard form of an LP problem, slack, surplus and artificial variables.	08
2.	**TRANSPORTATION PROBLEM** Formulation of transportation problem, types, initial basic feasible solution using different methods, optimal solution by MODI method, degeneracy in transportation problems, application of transportation problem concept for maximization cases. Assignment Problem-formulation, types, application to maximization cases and travelling salesman problem	14
3.	**PERT-CPM TECHNIQUES** Introduction, network construction - rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects	14

4.	**GAME THEORY** Formulation of games, types, solution of games with saddle point, graphical method of solving mixed strategy games, dominance rule for solving mixed strategy games. **SEQUENCING:** Basic assumptions, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines. Sequencing 2 jobs on 'm' machines using graphical method	**08**
5.	**REPLACEMENT** Replacement items deteriorating with time, when money value remains same Replacement of items which fail suddenly; Individual replacement policy Group replacement policy **QUEUING THEORY:** Queuing systems and their characteristics, Pure-birth and Pure death models (only equations), empirical queuing models – M/M/ 1 and M/M/C models and their steady state performance analysis.	**08**

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Define models for linear programming
2. Convert the linear variable problems to a mathematical model and depict by graphical method.
3. Apply artificial variable technique to solve a linear programming model.
4. Compute the minimum cost of transportation by Modi's method and Hungarian method.
5. Design a project network diagram and schedule the project activities and dura-tion.
6. Illustrate the strategies of different players in a game and find the best strategy by graphical and dominance method

TEXT BOOKS

1. Operations Research, P K Gupta and D S Hira, Chand Publications, New Delhi- 2007
2. Operations Research, Taha H A, Pearson Education

REFERENCE BOOKS

1. Operations Research, A P Verma, S K Kataria&Sons, 2008

2. Operations Research, Paneerselvan, PHI

3. Operations Research, A M Natarajan, P Balasubramani, Pearson Education,2005

4. Introduction to Operations Research, Hiller and Liberman, McGraw Hill.

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven Full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-4 and Unit-5 are compulsory, with one question from each Unit.
4. Unit-2 and Unit-3: Two questions to be set with choice.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : INSPECTION AND QUALITY CONTROL(CORE ELECTIVE)		
Course Code : ME651	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/ week : 03
Exam Duration: 3 Hrs		Exam Marks : 100

COURSE OBJECTIVES:

1. The student should learn different inspection procedures objectives followed in industry and economic aspects.

2. To impart definition of quality, components, concepts and different approaches followed like quality circles, cost of quality and economic considerations in quality.

3. To impart fundamentals of statistical quality control, and process capability

4. To impart different sampling techniques

5. To impart knowledge on various quality standards followed

Unit No.	Syllabus	No.of hours
1.	**INDUSTRIAL INSPECTION** Objectives and functions of inspection in industry, production/ inspection interaction, organization for industrial inspection, inspection procedures, economic aspect of inspection	08
2.	**CONCEPT OF QUALITY IN ENGINEERING** Meaning and significance of quality; essential components of quality; phases or elements for building quality; evolution of the concepts of quality; spiral of progress of quality; changing scope of quality activities; Ishikawa's seven quality tools; Quality Circles; Quality system economics, hidden quality costs; economic models of quality costs.	10
3.	**QUALITY CONTROL FUNCTION** Inspection versus quality control techniques, quality planning activities, organization for quality control. Fundamentals of statistical quality control, Juran's quality trilogy Charts for variables and attributes, application of control charts for averages, range, standard deviation, fraction defectives and number of non conformities per unit, Process capability analysis	10
4.	**ACCEPTANCE SAMPLING** Elementary concepts, sampling by attributes, single, double and multiple sampling plans, construction and use of operating characteristic curves	08
5.	**QUALITY MANAGEMENT SYSTEMS** Introduction to various quality standards	03

COURSE OUTCOMES: On completion of the course, student should be able to;

1. The student will have the knowledge of inspection activity and functions that are followed in industry.

2. The student can carry out different quality procedures using different quality tools like quality circles, determine quality costs.

3. The student is in a position to construct control charts using data available in an industry, can also dwell upon the status of a process whether in control or out of control and find number of defectives.

4. The student can carry out sampling techniques with an industrial application.

5. Understand various quality systems prevalent in industry.

TEXT BOOKS

1. Juran, J. M. and Gryna, F. M., Quality Planning & Analysis, Tata McGraw Hill, New Delhi (1995).

2. Grant, E. L., Statistical Quality Control, McGraw Hill International, New York (2005).

REFERENCE BOOKS

1. Feignbaum, A. V., Total Quality Control, McGraw Hill International, New York (1991).

2. Besterfield, D.H., Total Quality Management, Pearson Education Asia, New Delhi (2003)

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-4 and Unit-5 are compulsory, with one full question from each Unit.
4. Unit-2 and Unit-3: Two full questions to be set with choice

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)

CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : PRODUCT DESIGN & MANUFACTURING (CORE ELECTIVE)		
Course Code : ME652	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/ week : 03
Exam Duration: 3 Hrs		Exam Marks : 100

Course objectives:

1. Impart knowledge of mathematics, basic and applied sciences.

2. Ability to identify, formulate and solve mechanical engineering problems based on data interpretation, design, experiment and analysis of results.

3. Learn effective engineering communication.

4. Ability to work in teams on multi-disciplinary projects in industry and research organizations.

5. Develop awareness of the ethical, professional and environmental implications of work in a global and societal context.

6. Ability to self-learn modern engineering tools, techniques, skills and contemporary engineering practice, necessary for engineering work.

Unit No.	Syllabus	No.of hours
1.	**STAGES IN DESIGN PROCESS** Introduction to various stages of the design process: Formulation of problem, Generation of alternatives, Evaluation, Guided Redesign. Case study. **PRODUCT LIFE CYCLE** New product introduction: early introduction, increased product life. Life cycle management tools: System integration, QFD, House of quality, Pugh?s method, Pahl and Beitz method. Case studies.	10
2.	**VALUE ENGINEERING** Introduction, nature and measurement of value.Value analysis job plan.Creativity and techniques of creativity.Value analysis test. Case studies. **CONCURRENT/ REVERSE ENGINEERING** Introduction, basic principles, components, benefits of concurrent engineering. Concept of reverse engineering	10
3.	**MATERIAL SELECTION** Materials in design. The evolution of engineering materials. Design tools and material data. Function, material, shape and process. Material selection strategy, attribute limits, selection process, computer aided material selection. Case studies.	07

	PROCESS SELECTION Introduction. Process classification: shaping, joining and finishing. Systematic process selection. Ranking, process cost. Computer – aided process selection	
4.	**DESIGN FOR MANUFACTURE AND ASSEMBLY** Design for Manufacture and Assembly (DFMA). Reasons for not implementing DFMA. Advantages of DFMA with case studies. Design features and requirements with regard to assembly, production. Design for Manufacture in relation to any two manufacturing processes: machining and injection molding. Need, objectives	10
5.	**DESIGN FOR 'X'** Introduction. Design for: Safety, packaging and storage, quality, reliability, energy conservation, environment, aesthetics, ergonomics, maintenance, recyclability and disposal. Case studies. **PATENTS, LIABILITY AND ETHICS** Introduction.Protecting your design: patents, copyright, basic tools of design protection. Liability issues in product design. Ethical considerations.Examples/ case studies.	06

COURSE OUTCOMES: On completion of the course, student should be able to;

1. To apply knowledge of mathematics, science, and engineering design and conduct experiments, as well as to analyze and interpret data.

2. Tesign a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

3. Function on multidisciplinary teams identify, formulate and solve engineering problems. understand professional and ethical responsibility. communicate effectively.

4. Understand the impact of engineering solutions in a global, economic, environmental, and societal context.

5. Recognize the need to engage in life-long learning attain knowledge of contemporary issues use the techniques, skills, and modern engineering tools necessary for engineering practice.

TEXT BOOKS:

1. Karl T. Ulrich, Steven D. Eppinger Product Design & Development McGrawHill

REFERENCE BOOKS:

1. John M. Usher, Utpal Roy and H. R. Parasaei Integrated Product and Process Development Tata McGraw Hill

2. G. Boothroyd, P. Dewhurst and W. Knight Product Design for Manufacture and Assembly Marcel Dekker

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven full Questions to be set.
2. Five full Questions to be answered.
3. Unit-3, Unit-4 and Unit-5are compulsory, with one full question from each Unit.
4. Unit-1 and Unit-2: Two full questions to be set with choice

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : AUTOMOTIVE ENGINEERING (CORE ELECTIVE)		
Course Code : ME653	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/ week : 03
Exam Duration: 3 Hrs		Exam Marks : 100
Prerequisite	Elements of Mechanical Engineering, Applied Thermodynamics	

Course objectives:

1. To describe the basic systems and components of Automobiles.
2. To analyze Engines, other power generation modes and its allied mechanisms.
3. To emphasize on Fuel characteristics and Fuel flow systems.
4. To explain combustion phenomena and ignition systems.
5. To demonstrate Power transmission mechanisms.
6. To demonstrate Steering and Suspension systems.
7. To define super charging and Turbo charging.
8. To explain the body constructional details.

Unit No.	Syllabus	No.of hours
1.	**Engine Components And Cooling & Lubrication Systems** Spark Ignition (SI) & Compression Ignition (CI) engines, cylinder – arrangements and their relatives merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve and port timing diagrams, Types of combustion chambers for S.I. Engine and C.I. Engines, Compression ratio, methods of a Swirl generation, choice of materials for different engine components, engine positioning, cooling requirements, methods of cooling, thermostat valves, different lubrication arrangements. **Fuels, Fuel Supply Systems For Si And Ci Engines** Conventional fuels, alternative fuels, normal and abnormal combustion, cetane and octane numbers.	08
2.	**FUEL MIXTURE REQUIREMENTS FOR SI ENGINE** types of carburetors, C.D. & C.C. carburetors, multi point and single point fuel injection systems, fuel transfer pumps, Fuel filters, fuel injection pumps and injectors. **SUPERCHARGERS AND TURBOCHARGERS** Naturally aspirated engines, Forced Induction, Types of superchargers, Turbocharger construction and operation, Intercooler, Turbocharger lag	10
3.	**IGNITION SYSTEMS** Battery Ignition systems, magneto Ignition system, Transistor assist contacts. Electronic Ignition, Automatic Ignition advance systems.	10

	POWER TRAINS General arrangement of clutch, Principle of friction clutches, Torque transmitted, Constructional details, Fluid flywheel, Single plate, multiplate and centrifugal clutches. **GEAR BOX** Necessity for gear ratios in transmission, synchromesh gear boxes, 3, 4 and 5 speed gear boxes. Free-wheeling mechanism, planetary gears systems, over drives, fluid coupling and torque converters, Epicyclic gear box, principle of automatic transmission, calculation of gear ratios, Numerical calculations for torque transmission by clutches	
4.	**DRIVE TO WHEELS** Propeller shaft and universal joints, Hotchkiss and torque tube drives, differential, rear axle, different arrangements of fixing the wheels to rear axle, steering geometry, camber, king pin inclination, included angle, castor, toe in & toe out, condition for exact steering, steering gears, power steering, general arrangements of links and stub axle, over steer, under steer and neutral steer, numerical problems, types of chassis frames. **SUSPENSION SPRINGS** Requirements, Torsion bar suspension systems, leaf spring, coil spring, independent suspension for front wheel and rear wheel. Air suspension system	**06**
5.	**BRAKES** Types of brakes, Mechanical compressed air, vacuum and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes, drum brakes, Antilock - Braking systems, purpose and operation of antilock-braking system, ABS Hydraulic Unit, Rear-wheel antilock & Numerical Problems. **AUTOMOTIVE EMISSION CONTROL SYSTEMS** Automotive emission controls, Controlling crankcase emissions, Controlling evaporative emissions, Cleaning the exhaust gas, Controlling the air-fuel mixture, Controlling the combustion process, Exhaust gas recirculation, Treating the exhaust gas, Air-injection system, Air-aspirator system, Catalytic converter, Emission standards Euro and Bharatnorms	**05**

TEXT BOOKS

1. Automotive mechanics, William H Crouse & Donald L Anglin, 10th Ed. TMH2007

2. Automobile Engineering, Vol I and II, Kirpal Singh, 2002.

REFERENCE BOOKS:

1. Automotive mechanics: Principles and Practices, Joseph Heitner, D VanNostrand Company, Inc

2. Fundamentals of Automobile Engineering,K.K.Ramalingam, Scitech Publi-cations (India) Pvt. Ltd.

3. Automobile Engineering, R. B. Gupta, SatyaPrakashan, 4th edn. 1984.

SYLLABUS FOR CIE:

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)

CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	**1**	**2**		**3**		**4**	**5**

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven Full Questions to be set and Five full Questions to be answered.

2. Unit-1, Unit-4 and Unit-5 are compulsory, with one question from each Unit and from Unit-2 and Unit-3: Two questions to be set with choice

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Distinguish the types of fuels used in IC engines and categorise the types of transmissions and suspension systems used in modern automobiles.

2. Understand various sensors and actuators to actuate safety devices in automo-biles.

3. Work on the design of combustion chambers.

4. Build the basic starter and generator devices.

5. Understand the working of Anti lock braking systems and GPS systems

6. Compare the various emission control systems.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	2	1	1
6	3	3	2	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : INDUSTRIAL MANAGEMENT		
Course Code : ME661	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/ week : 03
Exam Duration: 3 Hrs		Exam Marks : 100

Course objectives:

1. Competently employ broad-based analytical tools and computers for decision-making and system design, analysis, and performance.
2. Assume managerial and leadership roles in their chosen professional careers while working in multi disciplinary teams.
3. To describe the most well-known theories and perspectives on management.
4. Engage in continuous learning by seeking out opportunities for higher education or ongoing training related to their employment.
5. Effectively adapt to the changing demands in the workplace and able to perform increasingly complex tasks, as well as tasks outside a field of expertise.

Unit No.	Syllabus	No.of hours
1.	**INTRODUCTION:** Historical perspective, contribution of Taylor, Henry Fayol, Gilbert, Charles Babbage, Henry Gantt to the evolution of management science in the Indian context. Ownership of Industries Proprietorship, partnership, joint stock companies, public and private undertakings, co-operative organizations. **QUALITY PHILOSOPHY:** The Meaning of Quality and Quality Improvement; Brief History of Quality Methodology; Statistical Methods for Quality Control and Improvement; Total Quality Management (quality philosophy, links between quality and productivity, quality costs legal aspects of quality implementing quality improvement). Definitions and aims of standardizations, techniques for standardization (Statistical Principles, Codification system, variety control and value Engineering).	12
2.	**WORK STUDY, INCENTIVES, HEALTH AND SAFETY:** Work study-Motion study and Method time study, principles of motion economy, charts and diagrams, Job evaluation systems, Multi skilling, Wage payment and plans, Incentive schemes, Training and Development, Safety Regulations and safe practices, Numerical problems.	10
3.	**MOTIVATION AND BEHAVIOR:** Hawthorns studies and its findings Maslows theory X and Y theory, Immaturity theory, Motivation hygiene theory, Pretence of needs and satisfaction of needs, goal oriented behavior, Integration of organizational goals and needs of employee.	10

	MARKETING MANAGEMENT: Concept of marketing management, functions of marketing, importance of marketing, problems of marketing of small enterprises, marketing mix.	
4.	**MANAGEMENT AND BEHAVIORAL APPROACH:** Contribution of Elton Mayo and Skinner to behavior sciences. Skills of a manager at various levels in an organization and inter-related systems, Understanding past behavior, Predicting future Behavior, Directing, Changing and Controlling behavior	08
5.	**PROCESS MANAGEMENT:** Definition of process management. Major process decisions-Process choice, Vertical integration, Resource flexibility, Customer involvement, Capital Intensity, Relationships between decisions, Service operation, Economics of scoop and gaining focus. Designing process. Process rearranging and process improvement **MANAGEMENT OF TECHNOLOGY:** Meaning and role of technology-primary areas of technology management, Management of technology and its role in improving business performance. Creating and applying technology-R and D stages and technology fusion. Technology strategy. Implementation guidelines for Technology.	12

COURSE OUTCOMES:

At the end of the course the student has

1. An ability to apply knowledge of mathematics, science, and engineering.
2. An ability to design and conduct experiments, as well as analyze and interpret data.
3. An ability to design a system, component, or process in order to meet desired needs within realistic constraints, such as economic, environmental, social, political, ethical, health and safety, manufacture ability, and sustain ability.
4. An ability to function on multidisciplinary teams.
5. An ability to identify, formulate, and solve engineering problems.
6. An understanding of professional and ethical responsibility.
7. An ability to communicate effectively the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
8. A recognition of the need for (and an ability to engage in) life-long learning.
9. A knowledge of contemporary issues.
10. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TEXT BOOKS:

1. **Principles of Management**, Koontz O Donnel,"Mc.Graw Hill Intl.Book Co.
2. **Statistical Quality Control:** E.L. Grant and R.S. Leavenworth, 7th edition, McGraw- Hill.
3. **Kotler on Marketing** , Philip D. Kotlar, Copyright © 1999, The Free Press.
4. **Entrepreneurial Development**, S.S. Khanka, S Chand and Company, Revised edition, 2014.

REFERENCE BOOKS

1. Essentials of management, Koontz Weirich,TATA McGraw Hill Intl. Book Co., 7th Edition

2. Management of Organizational Behaviour, Hersey Paul and Kenneth H," PHI

3. Operations management-strategy and analysis, LeeJ.Krajewski and Larry P. Ritzman, Fifth Edition Addison-Wiley

4. Organizational Behaviour, Stephen P Robbins, 9th Edition, Pearson Education Publications, ISBN-81-7808-561-5 2002

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven Full Questions to be set and Five full Questions to be answered.
2. Unit-2, Unit-3 and Unit-4 are compulsory, with one question from each Unit and from Unit-1 and Unit-5: Two questions to be set with choice

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)
(irrespective of portions covered due to whatever might be the reason)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : ADVANCED WELDING PROCESSES (CORE ELECTIVE)		
Course Code : ME662	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/ week : 03
Exam Duration: 3 Hrs		Exam Marks : 100

Course objectives:

1. The student gains information on different solid state welding processes.
2. To understand the working principle, weld characteristics and process parameters of high energy beam welding.
3. To understand the working principle, advantages, disadvantages of elctroslag, electrogas welding, thermit welding.
4. To understand the process of thermal cutting of materials, brazing and soldering.

Unit No.	Syllabus	No.of hours
1.	**SOLID STATE WELDING PROCESSES** Friction and friction stir welding, ultrasonic welding, adhesive bonding, diffusion bonding, explosion welding- basic principle, process variables, weld characteristics advantages, limitations and applications	07
2.	**HIGH ENERGY BEAM WELDING PROCESSES** Electron Beam Welding (EBW) - basic principle, equipment details, process characteristics, process variables, advantages, limitations and applications. Laser Beam Welding (LBW) – principle of operation, different laser mediums, advantages, limitations and applications	06
3.	**ELECTRO SLAG AND ELECTRO GAS WELDING** Principle of operation, equipment details, process variations, advantages, limitations and applications. **THERMIT WELDING** Basic principle, thermit mixtures, applications	10
4.	**THERMAL CUTTING** Oxy-Acetylene cutting-basic principle, metal powder cutting, chemical flux cutting, oxygen lancing; Arc cutting- brief introduction to oxygen/air / plasma/ metal arc cutting arc cutting and gouging; advantages, limitations and applications of various techniques	06
5.	**BRAZING AND SOLDERING** Introduction, brazing vs. soldering, various techniques, their advantages, limitations and applications; brazing & soldering consumables.	06

	UNDERWATER WELDING Introduction to wet and dry under water welding & cutting. WELDING IN SPACE Introduction, welding techniques, difficulties and advantages	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Describe the working principle, process characteristics, advantages, disadvantages and limitations of friction welding, friction stir welding, ultrasonic welding, adhesive boning, explosion welding and diffusion bonding.
2. Describethe mechanism, working principle and process characteristics of high energy beam welding.
3. Demonstrate with the mechanism, working principle and process characteristics of electroslag, electro gas welding and thermit welding, soldering, brazing, un-derwater welding .
4. Decide best cutting techniques for a particular application and their limitations.

TEXT BOOKS:

1. S.V.Nadkarni, "Modern Arc Welding Technology", Oxford & IBH.
2. R.Little, "Welding Technology, TMH. WELDING CODES AND STANDARDS ME-9111 L T P

REFERENCE BOOKS:

1. H.B.Cary, "Modern Arc Welding Technology", Englewood Cliffs, Prentice Hall.
2. Leonard P Connor, Welding Hand book, Volume I-III, AWS.
3. Metals Hand book , Volume 6, American Society of Metals.
4. Dave Smith, "Welding skills and technology", McGraw Hill.

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-2 and Unit-4are compulsory, with one full question from each Unit.
4. Unit-3 and Unit-5: Two full questions to be set with choice

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)

CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : ADVANCED HEAT TRANSFER (CORE ELECTIVE)		
Course Code : ME663	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/ week : 04
Exam Duration: 3 Hrs		Exam Marks : 100
Prerequisite	Basic & Applied Thermodynamics, Fluid Mechanics, Heat Transfer	

Course objectives:

1. To understand the heat conduction in solids with variable thermal conductivity and heat generation.

2. To solve steady and unsteady heat conduction problems using finite difference method.

3. To derive the differential equation of heat convection and solve problems related to flow over solids of different geometry.

4. To understand the heat transfer by natural convection and analyse the correlations for enclosed spaces to solve numerical problems.

5. To explain the phenomena of condensation and boiling and understand the correlations related to them.

6. To understand the mass transfer and different types of mass transfer.

Unit No.	Syllabus	No.of hours
1.	**HEAT CONDUCTION IN SOLIDS** The differential equation of heat conduction, Variable thermal conductivity, Heat generation, Two-dimensional steady state heat conduction, Unsteady state heat conduction processes, The finite difference method for solving steady and unsteady state heat conduction problems, Numericals.	07
2.	**HEAT TRANSFER BY FORCED CONVECTION** The differential equation of heat convection, Laminar and turbulent flow heat transfer in a pipe, The thermal boundary layer, Heat transfer in laminar flow over a flat plate, The integral method, Analogy between heat and momentum transfer, Heat transfer in turbulent flow over a flat plate, Flow across a cylinder, Flow across banks of tubes, Numericals	06
3.	**HEAT TRANSFER BY NATURAL CONVECTION** Introduction, Natural convection heat transfer from a vertical plate, Correlations for a horizontal cylinder and a horizontal plate, Correlations for enclosed spaces, Combined convection, Numericals.	06
4.	**CONDENSATION AND BOILING** Introduction, Film and drop condensation, Film condensation on a vertical plate, Condensation on horizontal tubes, Effect of superheated vapour and of non-condensable gases, Type of boiling, Correlations in saturated pool boiling, Flow boiling, Numericals	10
5.	**MASS TRANSFER** Introduction, Fick's law of diffusion, Steady state mass diffusion in a stationary medium, Diffusion in mixing medium, Convective mass transfer, Analogy between heat and mass transfer, Simultaneous heat and mass transfer, Numericals	10

TEXT BOOKS

1. A Text Book on Heat Transfer, S.P. Sukhatme, 4thEdition, Universities Press,2005.

2. Heat and Mass Transfer, P.K. Nag, 3rdEdition, Tata McGraw-Hill Publications,2011.

3. A Course in Heat and Mass Transfer, Domkundwar, Arora, Domkundwar, DhanpatRai Publications, 2005.

REFERENCE BOOKS

1. Heat and Mass Transfer, Cengel,Y.A., and Ghajar, A.J., 4thEdition, McGraw-Hill Publications, 2011.

2. Principles of Heat and Mass Transfer,Frank P. Incropera,David P. Dewitt, Theodore L. Bergman, and Adrienne S. Lavine, 7th Edition, Wiley Student Edition, 2013.

e-LEARNING RESOURCES

1. A Heat Transfer Text Book, John H Leinard IV and John H Leinard V, 3rdEdition, Phlogiston Press, Cambridge, Massachusetts, USA, 2008.

2. Heat and Mass Transfer: Mechanical Engineering Handbook, Kreith, F.,Boehm, R.F., et. al., Frank Kreith (Ed), Boca Raton: CRC Press LLC, 1999.

3. Fundamentals of Heat and Mass Transfer, Frank P. Incropera,David P. Dewitt,et. al. Frank P. Incropera (Ed), 6th Edition, John Wiley and Sons, 2007.

4. e-Journal: Frontiers in Heat and Mass Transfer,http://www.ThermalFluidsCentral.org

5. Videos, Student slides, Handouts, Lecture notes: http://www.nptel.ac.in

DATA HAND BOOK AND CHARTS

1. Heat and Mass Transfer Data Hand Book, C.P. Kothandaraman, S.Subramanyan, New Age International Publishers, 8th Edition, 2014.

2. Steam Tables with Mollier Diagram: SI Units, Mahesh M.Rathore,DhanpatRai Publishing Company, 2014.

SYLLABUS COVERAGE FOR CIE

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)

CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**
UNIT	**1**	**2**	**3**	**4**		**5**	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.

2.Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.

3.Each question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Describe conduction and convection heat transfer mechanisms, boiling, condensation and mass transfer.

2. Distinguish the heat and mass transfer modes with examples and illustrations.

3. Sketch and solve problems related to application of conduction, convection, boiling, condensation and mass transfer.

4. Compare and analyse different modes of heat transfer.

5. Derive mathematical expressions and equations to determine the heat and mass transfer rate.

6. Calculate the rate of heat and mass transfer and compute the performance of various heat and mass transfer systems.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	2	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : DESIGN LABORATORY		
Course Code : MEL67	No of Credits : L-T-P-SS 00:00:02:00 =01	No. of lecture hours/ week : 02
Exam Duration: 3 Hrs		Exam Marks : 50

Course objectives:

1. The main objective of this lab is to expose the student of mechanical engineering to various experimental techniques in order to prepare them for their professional career (Industrial and or R&D). The equipment's / instrumentation proposed are expected to provide the students a lot of insight into various experimental tech-niques in general and those connected with major mechanical systems in particular.

2. The experiment sequence is arranged in such a way to facilitate to introduce the students to engineering fundamentals, to develop their abilities to design experiments, and to motivate them to learn computer applications for data analysis

Unit No.	**Syllabus**	**No.of hours**
1.	**PHOTO-ELASTIC BENCH** 1. Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (longitudinal and torsional). 2. Determination of critical speed of a rotating shaft. 3. Determination of Fringe constant of Photoelastic material using (a) Circular disc subjected to diametral compression (b) Pure bending specimen (four point bending). 4. Determination of stress concentration using Photoelasticity for simple components like plate with a hole under tension or bending, circular disk with circular hole under compression, 2D Crane hook	**18**
2.	**GOVERNORS AND GYROSCOPES** 1. Determination of centrifugal force of Porter/ Watt /Hartnel Governor. (Only one or more). 2. Determination of Principal Stresses and strains in a member to combined loading using Strain rosettes. 3. Experiments on Gyroscope.	**18**

QUESTION PAPER PATTERN (SEE)

Q. No.	**Q1**	**Q2**
UNIT	**1**	**2**

SCHEME OF EXAMINATION (SEE)

Sl. No.	Particulars	Max. Marks	Break Up of Max. Marks		
			Write Up	Conduction of experiment	Specimen Calculation, Tabulation of Results and Plotting of Graph if any
1.	**Unit-1: Minor Experiment** (Any ONE from the list of experiments and it is purely individual Experiment) Q1	15	05	05	05
2.	**Unit-2: Major Experiment** (Any ONE Experiment from the list of experiments and it is a Group Experiment) Q2	25	05	10	10
3.	**Viva Voce**	10	-	-	-
	TOTAL MARKS	50	10	25	15

? Two Full Questions to be set.

? Students shall be to be answered two full Questions

? Each question(Experiments contains different Marks and it is clearly mentioned in the above table)

? Changing of Experiments is not allowed from any unite if changing of experiments allowed 50% marks will be deducted.

? Viva Voce is compulsory

REFERENCES TEXT BOOKS :

1. Advanced Mechanics of solids, L. S. Srinath, Tata Mc. Graw Hill, 2003

2. Theory of Elasticity, S. P. Timoshenko and J. N Gordier, Mc.Graw Hill International, 3rd edition, 1972

3. Theory of Elasticity, Dr. Sadhu Singh, Khanna Publications, 1988

4. Elasticity, Theory, Applications &Numericals, Martin H Sadd, Elsevier. 2005

5. Applied Elasticity, Seetharamu&Govindaraju, Interline Publishing

COURSE OUTCOMES: On completion of the course, student should be able to;

The major impact of the state of the art machine design lab is the exposure the students get to the modern experimental techniques and instrumentation. The experiments are planned in such a way that by the end of the course, the student is ex-pected to have enough potential to design the experimentation as required at that point of time.

1. The major impact of the state of the art machine design lab is the exposure the students get to the modern experimental techniques and instrumentation.

2. Students will be able to understand the essence of kinetics and dynamics through experiments.

3. Students will be able to visualize the stresses developed in an object through photo elasticity implementation of concept of stress concentration in design.

4. The experiments are planned in such a way that by the end of the course, and the student has potential to design the experimentation as required at that point of time.

MAPPING OF COs WITH POs

COs /POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	3	2	2	3	3	1	2
CO2	2	3	3	2	2	1	2	2	3	3	3	2
CO3	3	3	3	2	3	2	1	1	3	2	3	2
CO4	3	3	2	2	3	3	1	1	2	2	3	3

High 3 **Medium 2** **Low 1**

COURSE TITLE : CIM & AUTOMATION LABORATORY		
Course Code : MEL68	No of Credits : L-T-P-SS 00:00:02:00 =01	No. of lecture hours/ week : 02
Exam Duration: 3 Hrs		Exam Marks : 50

Course objectives:

1. Computer based numerically controlled machine tools are increasingly finding place in industries.

2. Further integration of the computer Aided Design Drafting (CADD), Which has been in use in the industry for some years now, with (CAM) Operations has led to efficient product design & prototyping and shorter production runs.

3. The need to absorb, CAD/ CAM technology for its effectives has, therefore, become imperative.

4. This course is being introduced as Practical course of BE programme in mechanical engineering.

5. The course aims at developing appreciation of the use of CAD/CAM environment, its Components, their functions, and methods of using the existing CAD/ CAM software, in general, with a view to improve efficiency in drafting and designing

Unit No.	Syllabus	No.of hours
1.	**PART PROGRAMMING** ? ?CNC part programming using CAM packages. ? ?Simulation of Turning, Drilling, Milling operations. ? ?Three typical simulations to be carried out using simulation packages like Master- CAM, or any equivalent software	20
2.	**ONLY FOR DEMO/VIVA VOCE)** ? ? FMS (Flexible Manufacturing System): Programming of Automatic storage and Retrieval system (ASRS) and linear shuttle conveyor Interfacing CNC lathe, milling with loading unloading arm and ASRS to be carried out on simple components. ? ?Robot programming: Using Teach Pendent & Offline programming to perform pick and place, stacking of objects, 2 pro-grams	08
3.	**(ONLY FOR DEMO/VIVA VOCE)** Pneumatics and Hydraulics, Electro-Pneumatics: Three typical experiments on Basics of these topics to be conducted	08

REFERENCES TEXT BOOKS :

1. Advanced Mechanics of solids, L. S. Srinath, Tata Mc. Graw Hill, 2003

2. Theory of Elasticity, S. P. Timoshenko and J. N Gordier, Mc.Graw Hill International, 3rd edition, 1972

3. Theory of Elasticity, Dr. Sadhu Singh, Khanna Publications, 1988

4. Applied Elasticity, Seetharamu&Govindaraju, Interline Publishing

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2
UNIT	1	2

SCHEME OF EXAMINATION (SEE)

SI. No.	Particulars	Max. Marks	Break Up of Max. Marks		
			Write Up	Conduction of experiment / Modelling prossing	Out Put Results (Various turning and milling operations) and Plotting Time, power, Graph if any and generate NC program if required)
1.	**Unit-1: Minor Experiment** (Any ONE from the list of experiments and it is purely individual Experiment) Q1	15	05	05	05
2.	**Unit-2: Major Experiment** (Any ONE Experiment from the list of experiments and it is a Group Experiment) Q2	25	05	10	10
3.	**Viva Voce**	10	-	-	-
	TOTAL MARKS	50	10	25	15

? Two Full Questions to be set.

? Students shall be to be answered two full Questions.

? Each question(Experiments contains different Marks and it is clearly mentioned in the above table)

? Changing of Experiments is not allowed from any unite if changing of experiments allowed 50% marks will be deducted.

? Viva Voce is compulsory

COURSE OUTCOMES: On completion of the course, student should be able to;

1. At the end of the COURSE, he must be in a position to giving the solutions by his depth of the COURSE knowledge to perform any machining operation with maximum accuracy as per the required standard by CNC easily.

2. This will enhance to improve the large production with zero rejection of industries.

3. Thus industrial peoples can able to fulfill the customer requirements

MAPPING OF COs WITH POs

COs /POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	3	2	2	3	3	1	2
CO2	2	3	3	2	2	1	2	2	3	3	3	2
CO3	3	3	3	2	3	2	1	1	3	2	3	2
CO4	3	3	2	2	3	3	1	1	2	2	3	3

High 3 **Medium 2** **Low 1**

COURSE TITLE : MINI-PROJECT WORK		
Course Code : MEP69	No of Credits : L-T-P-SS 00:00:04:00 =02	No. of lecture hours/ week : 04
Exam Duration: 3 Hrs		Exam Marks : 50

Course objectives:

1. To instill an atmosphere in students to find a working situation and discover the workable area

2. To insure a transition from planned laboratory course to planning one indepen-dently.

Unit No.	Syllabus	No.of hours
1.	**FABRICATION** Simple fabrication related to mechanical projects on a mini scale	**52**
2.	**MODELING & ANALYSIS** Projects using Modeling and analysis tools project related to real-istic problems of mechanical stream	**52**

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Literature review on national journal standards and define the problem

2. Design Experiments scientifically / Perform Numerical Analysis / Develop Analytical models to Interpret the Results and Prepare quality document

SCHEME OF VALUATION:

Departments shall constitute a Departmental Project Review Committee(faculty+guide)

Project evaluation shall be done by the departmental committee along with the guide and the marks shall be submitted to exam section.

CIE-1: project evaluation in the middle of the semester for 25 marks. CIE-2: project evaluation at the end of the semester for 25 marks.

SEE: evaluation by both internal and external examiners for 50 marks by conducting project viva-voce.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

BATCH 2014-18 (PROPOSED)

7th Semester

			L	T	P	C
1	HS04	Intellectual Property Rights	2	0	0	2.0
2	ME71	Control Engineering	4	0	0	4.0
3	ME72	Hydraulics & Pneumatics	4	0	0	4.0
4	ME731	Inspection Quality Control	4	0	0	4.0
	ME732	Product Design & Manufacturing	3	0	0	3.0
	ME733	Automotive Engineering	3	0	0	3.0
5	ME741	Industrial Management	3	0	0	3.0
	ME742	Advanced Welding Process	3	0	0	3.0
	ME743	Advanced heat Transfer	3	0	0	3.0
6	ME751	Engineering Tribology	3	0	0	3.0
	ME752	Industrial Robotics	3	0	0	3.0
	ME753	Solar Energy Engineering	3	0	0	3.0
7	MEP76	Project Work Phase-I	3	0	0	3.0
8	IDE	Inter Departmental Electives List	0	0	0	0.0
		SEVENTH SEMESTER END CREDITS				**23.0**

BATCH 2014-18 (PROPOSED)

8th Semester

			L	T	P	C
1	ME811	Rapid Prototyping	3	0	0	3.0
	ME812	Internal Combustion Engines	3	0	0	3.0
	ME813	Engineering Economics	3	0	0	3.0
2	ME821	Computer Integrated Manufacturing	3	0	0	3.0
	ME822	Computational Fluid Dynamics	3	0	0	3.0
	ME823	Smart Materials	3	0	0	3.0
3	MEL83	CAMA Laboratory	0	2	2	2.0
4	MEL84	Control Engineering Laboratory	0	2	2	2.0
5	MES85	Subject Seminar	0	2	2	2.0
6	MEP86	Project Work Phase-II	2	4	16	12.0
		EIGHTH SEMESTER END CREDITS				**24.0**
		FOURTH YEAR CUMULATIVE CREDITS				**200.0**

VII Semester (2014-15)

COURSE TITLE : INTELLECTUAL PROPERTY RIGHTS		
Course Code : HS04	No of Credits : 2	No. of lecture hours/ week : 2
Exam Duration: 2 Hrs	Exam Marks : 50	Exam Marks : 26

Course objectives:

1. The main objective of the IPR is to make the students aware of their rights for the protection of their invention done in their project work.

2. To get registration in our country and foreign countries of their invention, designs and thesis or theory written by the students during their project work and for this they must have knowledge of patents, copy right, trademarks, designs and information Technology Act.

3. Further teacher will have to demonstrate with products and ask the student to identify the different types of IPR's.

Unit No.	Syllabus	No.of hours
1.	**INTRODUCTION:** Meaning of property, Origin, Nature, Meaning of Intellectual Property Rights, Provision of IPR under TRIPS and WTO. Kinds of Intellectual property rights—Copy Right, Patent, Trade Mark, Trade Secret and trade dress, Design, Layout Design, Geographical Indication, Plant Varieties and Traditional Knowledge.	03
2.	**PATENT RIGHTS AND COPY RIGHTS—** Origin, Meaning of Patent, Types, Inventions which are not patentable, Registration Procedure, Rights and Duties of Patentee, Assignment and licence, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties. **COPY RIGHT—** Origin, Definition & Types of Copy Right, Registration procedure, Assignment & licence, Terms of Copy Right, Infringement, Remedies, Copy rights with special reference to software.	10
3.	**TRADE MARKS —** Origin, Meaning & Nature of Trade Marks, Types, Registration of Trade Marks, Infringement & Remedies, Offences relating to Trade Marks, Passing Off, Penalties.	04
4.	**DESIGN-** Meaning, Definition, Object, Registration of Design, Cancellation of Registration, International convention of design-types and functions. Semiconductor Integrated circuits and layout design Act-2000.	05
5.	**BASIC TENENTS OF INFORMATION TECHNOLOGY ACT-2000-** Cyber crimes, digital signature and E-Commerce.	04

Course outcomes:

1. The students once they complete their academic projects, they get awareness of acquiring the patent

2. They also learn to have copyright for their innovative works.

3. They also get the knowledge of plagiarism in their innovations which can be questioned legally.

TEXT BOOKS:

1. Intellectual Property Rights and the Law, Gogia Law Agency, by Dr. G.B. Reddy
2. Law relating to Intellectual Property, Universal Law Publishing Co, by Dr. B.L.Wadehra
3. IPR by P. Narayanan
4. Law of Intellectual Property, Asian Law House, Dr.S.R. Myneni.

COURSE TITLE : CONTROL ENGINEERING		
Course Code : ME71	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/ week : 04
Exam Duration: 3 Hrs		Exam Marks : 100

Course objectives:

1. Model the mechanical, electrical, thermal, hydraulic and analogous systems through differential equations.
2. Analyze compensators and other modes and its allied mechanisms.
3. Emphasize on transient characteristics and response of the systems.
4. Define Routh-Hurwitz criteria and signal flow systems.
5. Demonstrate compensators, automatic controllers and electrical systems
6. Construct root locus, bode plots and Nyquist plots using MATLAB

Unit No.	Syllabus	No.of hours
1.	**INTRODUCTION** Concept of automatic controls, Open loop and closed loop systems, Concepts of feedback, requirements of an ideal control system. Mathematical Models**:** Transfer function models, models of mechanical systems, models of electrical circuits, DC and AC motors in control systems, models of thermal systems, models of hydraulic systems, pneumatic system, Analogous systems: Force voltage, Force current	10
2.	**BLOCK DIAGRAMS AND SIGNAL FLOW GRAPHS** Transfer Functions definition, function, blocks representation of systems elements, reduction of block diagrams, Signal flow graphs: Mason's gain formula. **TRANSIENT AND STEADY STATE RESPONSE ANALYSIS:** Introduction, first order and second order system response to step, ramp and impulse inputs, concepts of time constant and its importance in speed of response. System stability: Routh's-Hurwitz Criterion; Types of controllers- Proportional, Integral Proportional Integral, Proportional Integral Differential controllers.	12
3.	**FREQUENCY RESPONSE ANALYSIS** Polar plots, Nyquist stability criterion, Stability analysis, Relative stability concepts, Gain margin and phase margin, M&N circles	10
4.	**FREQUENCY RESPONSE ANALYSIS USING BODE PLOTS** Bode attenuation diagrams, Stability analysis using Bode plots, Simplified Bode Diagrams	10
5.	**ROOT LOCUS PLOTS** Root Loci; Definition, General rules for constructing and Analysis using root locus plots	10

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Describe fundamentals of control elements
2. Develop mathematical models of different mechanical and electrical systems.
3. Analyze steady state and transient response of first order and second order systems.
4. Analyze system stability through root locus and Bode plots.
5. Illustrate programming skills for control engineering in MATLAB environment

TEXT BOOKS:

1. **Modern Control Engineering,**KatsuhikoOgatta, Pearson Education,2004.
2. **Control Systems Principles and Design,**M.Gopal, TMH,2000.

REFERENCE BOOKS :

1. **Modern Control Systems**, Richard.C.Dorf and Robert.H.Bishop, AddisonWesley,1999
2. **System dynamics & control**, Eronini-Umez, Thomson Asia pte Ltd. singapore,2002.
3. **Feedback Control System**, Schaum's series. 2001.

SCHEME OF EXAMINATION (Question Paper Pattern)

1. SEVEN full questions to be set
2. FIVE full questions to be answered
3. Questions from Unit 3, Unit 4 and Unit 5 are COMPULSORY
4. TWO questions with CHOICE from Unit 1 and Unit 2

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : HYDRAULICS AND PNEUMATICS		
Course Code : ME72	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/ week : 04
Exam Duration: 3 Hrs		Exam Marks : 100
Pre-requisites	Fluid Mechanics	

Course objectives:

1. To explain the operation of the main elements of an industrial hydraulic and pneumatic system.
2. To define basic fluid power terms and units.
3. To identify Hydraulic and Pneumatic graphic symbols.
4. To describe fluid power components.
5. To calculate basic operations for sizing hydraulic and pneumatic components.
6. To perform basic fluid power maintenance procedures.

Unit No.	Syllabus	No.of hours
1.	**INTRODUCTION TO HYDRAULIC POWER** Definition of hydraulic system, advantages, limitations, applications, Pascal's law, structure of hydraulic control system, problems on Pascal's law. **PUMPS** Classification, Pumping theory of positive displacement pumps, construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps, Pump performance characteristics, pump Selection factors.	08
2.	**HYDRAULIC ACTUATORS AND MOTORS** Classification cylinder and hydraulic motors, Linear Hydraulic Actuators [cylinders], single and double acting cylinder, Mechanics of Hydraulic Cylinder Loading, cushioning, special types of cylinders. **CONTROL COMPONENTS IN HYDRAULIC SYSTEMS** Classification of control valves, Directional Control Valves-ANSI Symbolic representation, constructional features of poppet, sliding spool, rotary type valves solenoid and pilot operated DCV, shuttle valve, check valves, Pressure control valves - types, direct operated types and pilot operated types. Flow Control Valves - compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation.	09

3.	**HYDRAULIC CIRCUIT ANALYSIS** Control of Single and Double Acting Hydraulic Cylinder, Regenerative circuit, Pump Unloading Circuit, Double Pump Hydraulic System, Counter balance Valve Application, Hydraulic Cylinder Sequencing Circuits, Automatic cylinder reciprocating system, Locked Cylinder using Pilot check Valve, Cylinder synchronizing circuit using different methods, factors affecting synchronization, Speed Control of Hydraulic Motors, Safety circuit, Accumulators, types, construction and applications with circuits.	08
4.	**INTRODUCTION TO PNEUMATIC CONTROL** Definition of pneumatic system, advantages, limitations, applications, Choice of working medium. Characteristic of compressed air. Structure of Pneumatic control System, fluid conditioners and FRL unit. **PNEUMATIC ACTUATORS** Linear cylinder - Types, Conventional type of cylinder- working, End position cushioning, seals, mounting arrangements- Applications. Rod - Less cylinders types, working, advantages, Rotary cylinders-types construction and application, symbols. **COMPRESSED AIR** Production of compressed air- Preparation of compressed air-Driers, Filters, Regulators, Lubricators, Distribution of compressed air Piping layout.	13
5.	**PNEUMATIC CONTROL VALVES** DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve, Quick exhaust valve, time delay valve, shuttle valve, twin pressure valve, symbols. Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, speed control of cylinders - supply air throttling and Exhaust air throttling and Exhaust air throttling. **SIGNAL PROCESSING ELEMENTS** Use of Logic gates - OR and AND gates in pneumatic applications. Practical Examples involving the use of logic gates, Pressure dependant controls- types - construction - practical applications, Time dependent controls principle. Construction, practical applications. **ELECTRO- PNEUMATIC CONTROL** Principles - signal input and output, pilot assisted solenoid control of directional control valves, relay and contactors. Control circuitry for simple signal cylinder application.	14

TEXT BOOKS:

1. **"Fluid Power with Applications",** Anthony Esposito,6th Ed., Pearson Educa-tion, Inc, 2000.

2. **Pneumatics and Hydraulics',** Andrew Parr, JaicoPublilishing Co.

REFERENCE BOOKS:

1. Oil Hydraulic systems', Principles and Maintenance S. R. Majurr, TataMcGraw Hill Publishing Company Ltd. - 2001

3. Hydraulic & Pneumatic Power for Production', Harry L. Stewart

2. Industrial Hydraulics',Pippenger, Hicks" McGraw Hill, New York

4. Pneumatic Systems', S. R. Majumdar, Tata McGraw Hill Publish 1995

5. Power Hydraulics' Michael J Pinches & John G Ashby, Prentice Hall. SYLLABUS COVERAGE FOR CIE:

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-2 and Unit-3 are compulsory, with one full question from each Unit.
4. Unit-4 and Unit-5: Two full questions to be set with choice

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Outline the basics of hydraulics and pneumatics.
2. Identify symbols and notations associated with hydraulics and pneumatics.
3. Solve simple numerical problems on operations.
4. Select basic fluid power maintenance procedures.
5. Design simple hydraulic and pneumatic circuits
6. Use hydraulics and pneumatics models for development of automatic

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	3	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : INSPECTION QUALITY CONTROL (CORE ELECTIVE)		
Course Code : ME731	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/ week : 03
Exam Duration: 3 Hrs		Exam Marks : 100

COURSE OBJECTIVES:

1. The student should learn different inspection procedures objectives followed in industry and economic aspects.
2. To impart definition of quality, components, concepts and different approaches followed like quality circles, cost of quality and economic considerations in quality.
3. To impart fundamentals of statistical quality control, and process capability
4. To impart different sampling techniques
5. To impart knowledge on various quality standards followed

Unit No.	Syllabus	No.of hours
1.	**INDUSTRIAL INSPECTION** Objectives and functions of inspection in industry, production/ inspection interaction, organization for industrial inspection, inspection procedures, economic aspect of inspection	08
2.	**CONCEPT OF QUALITY IN ENGINEERING** Meaning and significance of quality; essential components of quality; phases or elements for building quality; evolution of the concepts of quality; spiral of progress of quality; changing scope of quality activities; Ishikawa's seven quality tools; Quality Circles; Quality system economics, hidden quality costs; economic models of quality costs.	10
3.	**QUALITY CONTROL FUNCTION** Inspection versus quality control techniques, quality planning activities, organization for quality control. Fundamentals of statistical quality control, Juran's quality trilogy Charts for variables and attributes, application of control charts for averages, range, standard deviation, fraction defectives and number of non conformities per unit, Process capability analysis	10
4.	**ACCEPTANCE SAMPLING** Elementary concepts, sampling by attributes, single, double and multiple sampling plans, construction and use of operating characteristic curves	08
5.	**QUALITY MANAGEMENT SYSTEMS** Introduction to various quality standards	03

COURSE OUTCOMES: On completion of the course, student should be able to;

1. The student will have the knowledge of inspection activity and functions that are followed in industry.
2. The student can carry out different quality procedures using different quality tools like quality circles, determine quality costs.
3. The student is in a position to construct control charts using data available in an industry, can also dwell upon the status of a process whether in control or out of control and find number of defectives.
4. The student can carry out sampling techniques with an industrial application.
5. Understand various quality systems prevalent in industry.

TEXT BOOKS

1. Juran, J. M. and Gryna, F. M., Quality Planning & Analysis, Tata McGraw Hill, New Delhi (1995).
2. Grant, E. L., Statistical Quality Control, McGraw Hill International, New York (2005).

REFERENCE BOOKS

1. Feignbaum, A. V., Total Quality Control, McGraw Hill International, New York (1991).
2. Besterfield, D.H., Total Quality Management, Pearson Education Asia, New Delhi (2003)

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-4 and Unit-5 are compulsory, with one full question from each Unit.
4. Unit-2 and Unit-3: Two full questions to be set with choice

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)

CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : PRODUCT DESIGN & MANUFACTURING CORE ELECTIVE)		
Course Code : ME732	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/ week : 03
Exam Duration: 3 Hrs		Exam Marks : 100

Course objectives:

1. Impart knowledge of mathematics, basic and applied sciences.
2. Ability to identify, formulate and solve mechanical engineering problems based on data interpretation, design, experiment and analysis of results.
3. Learn effective engineering communication.
4. Ability to work in teams on multi-disciplinary projects in industry and research organizations.
5. Develop awareness of the ethical, professional and environmental implications of work in a global and societal context.
6. Ability to self-learn modern engineering tools, techniques, skills and contemporary engineering practice, necessary for engineering work.

Unit No.	Syllabus	No.of hours
1.	**STAGES IN DESIGN PROCESS** Introduction to various stages of the design process: Formulation of problem, Generation of alternatives, Evaluation, Guided Redesign. Case study. **PRODUCT LIFE CYCLE** New product introduction: early introduction, increased product life. Life cycle management tools: System integration, QFD, House of quality, Pugh?s method, Pahl and Beitz method. Case studies.	10
2.	**VALUE ENGINEERING** Introduction, nature and measurement of value.Value analysis job plan.Creativity and techniques of creativity.Value analysis test. Case studies. **CONCURRENT/ REVERSE ENGINEERING** Introduction, basic principles, components, benefits of concurrent engineering. Concept of reverse engineering	10
3.	**MATERIAL SELECTION** Materials in design.The evolution of engineering materials. Design tools and material data. Function, material, shape and process. Material selection strategy, attribute limits, selection process, computer aided material selection. Case studies. **PROCESS SELECTION**	07

	Introduction. Process classification: shaping, joining and finishing. Systematic process selection. Ranking, process cost. Computer – aided process selection	
4.	**DESIGN FOR MANUFACTURE AND ASSEMBLY** Design for Manufacture and Assembly (DFMA). Reasons for not implementing DFMA.Advantages of DFMA with case studies. Design features and requirements with regard to assembly, production. Design for Manufacture in relation to any two manufacturing processes: machining and injection molding. Need, objectives	**06**
5.	**DESIGN FOR 'X'** Introduction. Design for: Safety, packaging and storage, quality, reliability, energy conservation, environment, aesthetics, ergonomics, maintenance, recyclability and disposal. Case studies. **PATENTS, LIABILITY AND ETHICS** Introduction.Protecting your design: patents, copyright, basic tools of design protection. Liability issues in product design. Ethical considerations.Examples/ case studies.	**06**

COURSE OUTCOMES: On completion of the course, student should be able to;

1.To apply knowledge of mathematics, science, and engineering design and conduct experiments, as well as to analyze and interpret data.

2. Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

3. Function on multidisciplinary teams identify, formulate and solve engineering problems. understand professional and ethical responsibility. communicate effectively.

4. Understand the impact of engineering solutions in a global, economic, environmental, and societal context.

5. Recognize the need to engage in life-long learning attain knowledge of contemporary issues use the techniques, skills, and modern engineering tools necessary for engineering practice.

TEXT BOOKS:

1. Karl T. Ulrich, Steven D. Eppinger Product Design & Development McGrawHill

REFERENCE BOOKS:

1. John M. Usher, Utpal Roy and H. R. Parasaei Integrated Product and Process Development Tata McGraw Hill

2. G. Boothroyd, P. Dewhurst and W. Knight Product Design for Manufacture and Assembly Marcel Dekker

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven full Questions to be set.
2. Five full Questions to be answered.
3. Unit-3, Unit-4 and Unit-5are compulsory, with one full question from each Unit.
4. Unit-1 and Unit-2: Two full questions to be set with choice

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)

CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : AUTOMOTIVE ENGINEERING (CORE ELECTIVE)		
Course Code : ME733	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/ week : 03
Exam Duration: 3 Hrs		Exam Marks : 100
Pre-requisites	Elements of Mechanical Engineering, Applied Thermodynamics	

Course objectives:

1. To describe the basic systems and components of Automobiles.
2. To analyze Engines, other power generation modes and its allied mechanisms.
3. To emphasize on Fuel characteristics and Fuel flow systems.
4. To explain combustion phenomena and ignition systems.
5. To demonstrate Power transmission mechanisms.
6. To demonstrate Steering and Suspension systems.
7. To define super charging and Turbo charging.
8. To explain the body constructional details.

Unit No.	Syllabus	No.of hours
1.	**Engine Components And Cooling & Lubrication Systems** Spark Ignition (SI) & Compression Ignition (CI) engines, cylinder – arrangements and their relatives merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve and port timing diagrams, Types of combustion chambers for S.I. Engine and C.I. Engines, Compression ratio, methods of a Swirl generation, choice of materials for different engine components, engine positioning, cooling requirements, methods of cooling, thermostat valves, different lubrication arrangements. **FUELS, FUEL SUPPLY SYSTEMS FOR SI AND CI ENGINES** Conventional fuels, alternative fuels, normal and abnormal combustion, cetane and octane numbers.	10
2.	**FUEL MIXTURE REQUIREMENTS FOR SI ENGINE** types of carburetors, C.D. & C.C. carburetors, multi point and single point fuel injection systems, fuel transfer pumps, Fuel filters, fuel injection pumps and injectors. **SUPERCHARGERS AND TURBOCHARGERS** Naturally aspirated engines, Forced Induction, Types of superchargers, Turbocharger construction and operation, Intercooler, Turbocharger lag	10
3.	**IGNITION SYSTEMS** Battery Ignition systems, magneto Ignition system, Transistor assist contacts. Electronic Ignition, Automatic Ignition advance systems. **POWER TRAINS** General arrangement of clutch, Principle of friction clutches, Torque transmitted, Constructional details, Fluid flywheel, Single plate, multi-plate and centrifugal clutches. **GEAR BOX** Necessity for gear ratios in transmission, synchromesh gear boxes, 3, 4 and 5 speed gear boxes. Free-wheeling mechanism, planetary gears systems, over drives, fluid coupling and torque converters, Epicyclic gear box, principle of automatic transmission, calculation of gear ratios, Numerical calculations for torque transmission by clutches	10
4.	**DRIVE TO WHEELS** Propeller shaft and universal joints, Hotchkiss and torque tube drives, differential, rear axle, different arrangements of fixing the wheels to rear axle, steering geometry, camber, king pin inclination, included angle, castor, toe in & toe out, condition for exact steering, steering gears, power steering, general arrangements of links and stub axle, over steer, under steer and neutral steer, numerical problems, types of chassis frames. **SUSPENSION SPRINGS** Requirements, Torsion bar suspension systems, leaf spring, coil spring, independent suspension for front wheel and rear wheel. Air suspension system	06
5.	**BRAKES** Types of brakes, Mechanical compressed air, vacuum and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes, drum brakes, Antilock - Braking systems, purpose and operation of antilock-braking system, ABS Hydraulic Unit, Rear-wheel antilock & Numerical Problems. **AUTOMOTIVE EMISSION CONTROL SYSTEMS** Automotive emission controls, Controlling crankcase emissions, Controlling evaporative emissions, Cleaning the exhaust gas, Controlling the air-fuel mixture, Controlling the combustion process, Exhaust gas recirculation, Treating the exhaust gas, Air-injection system, Air-aspi-rator system, Catalytic converter, Emission standards- Euro and Bharatnorms	05

TEXT BOOKS

1. Automotive mechanics, William H Crouse & Donald L Anglin, 10thEd. TMH2007

2. Automobile Engineering, Vol I and II, Kirpal Singh, 2002.

REFERENCE BOOKS:

1. Automotive mechanics: Principles and Practices, Joseph Heitner, D VanNostrand Company, Inc

2. **Fundamentals of Automobile Engineering,**K.K.Ramalingam, Scitech Publications (India) Pvt. Ltd.

3. **Automobile Engineering**, R. B. Gupta, SatyaPrakashan, 4th edn. 1984.

SYLLABUS FOR CIE:

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)

CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2		3		4	5

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven Full Questions to be set and Five full Questions to be answered.

2. Unit-1, Unit-4 and Unit-5 are compulsory, with one question from each Unit and from Unit-2 and Unit-3: Two questions to be set with choice

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Distinguish the types of fuels used in IC engines and categorise the types of transmissions and suspension systems used in modern automobiles.

2. Understand various sensors and actuators to actuate safety devices in automobiles.

3. Work on the design of combustion chambers.

4. Build the basic starter and generator devices.

5. Understand the working of Anti lock braking systems and GPS systems

6. Compare the various emission control systems.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : INDUSTRIAL MANAGEMENT		
Course Code : ME741	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/ week : 03
Exam Duration: 3 Hrs		Exam Marks : 100

Course objectives:

1. Competently employ broad-based analytical tools and computers for decision-making and system design, analysis, and performance.

2. Assume managerial and leadership roles in their chosen professional careers while working in multi disciplinary teams.

3. To describe the most well-known theories and perspectives on management.

4. Engage in continuous learning by seeking out opportunities for higher education or ongoing training related to their employment.

5. Effectively adapt to the changing demands in the workplace and able to perform increasingly complex tasks, as well as tasks outside a field of expertise.

Unit No.	Syllabus	No.of hours
1.	**INTRODUCTION:** Historical perspective, contribution of Taylor, Henry Fayol, Gilbert, Charles Babbage, Henry Gantt to the evolution of management science in the Indian context. Ownership of Industries Proprietorship, partnership, joint stock companies, public and private undertakings, co-operative organizations. **QUALITY PHILOSOPHY:** The Meaning of Quality and Quality Improvement; Brief History of Quality Methodology; Statistical Methods for Quality Control and Improvement; Total Quality Management (quality philosophy, links between quality and productivity, quality costs legal aspects of quality implementing quality improvement). Definitions and aims of standardizations, techniques for standardization (Statistical Principles, Codification system, variety control and value Engineering).	12
2.	**WORK STUDY, INCENTIVES, HEALTH AND SAFETY:** Work study-Motion study and Method time study, principles of motion economy, charts and diagrams, Job evaluation systems, Multi skilling, Wage payment and plans, Incentive schemes, Training and Development, Safety Regulations and safe practices, Numerical problems.	10
3.	**MOTIVATION AND BEHAVIOR:** Hawthorns studies and its findings Maslows theory X and Y theory, Immaturity theory, Motivation hygiene theory, Pretence of needs and satisfaction of needs, goal oriented behavior, Integration of organizational goals and needs of employee.	10

	MARKETING MANAGEMENT: Concept of marketing management, functions of marketing, importance of marketing, problems of marketing of small enterprises, marketing mix.	
4.	**MANAGEMENT AND BEHAVIORAL APPROACH:** Contribution of Elton Mayo and Skinner to behavior sciences. Skills of a manager at various levels in an organization and inter-related systems, Understanding past behavior, Predicting future Behavior, Directing, Changing and Controlling behavior	**08**
5.	**PROCESS MANAGEMENT:** Definition of process management. Major process decisions-Process choice, Vertical integration, Resource flexibility, Customer involvement, Capital Intensity, Relationships between decisions, Service operation, Economics of scoop and gaining focus. Designing process. Process rearranging and process improvement **MANAGEMENT OF TECHNOLOGY:** Meaning and role of technology-primary areas of technology management, Management of technology and its role in improving business performance. Creating and applying technology-R and D stages and technology fusion. Technology strategy. Implementation guidelines for Technology.	**12**

COURSE OUTCOMES:

At the end of the course the student has

1. An ability to apply knowledge of mathematics, science, and engineering.
2. An ability to design and conduct experiments, as well as analyze and interpret data.
3. An ability to design a system, component, or process in order to meet desired needs within realistic constraints, such as economic, environmental, social, political, ethical, health and safety, manufacture ability, and sustain ability.
4. An ability to function on multidisciplinary teams.
5. An ability to identify, formulate, and solve engineering problems.
6. An understanding of professional and ethical responsibility.
7. An ability to communicate effectively the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
8. A recognition of the need for (and an ability to engage in) life-long learning.
9. A knowledge of contemporary issues.
10. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TEXT BOOKS:

1. **Principles of Management**, Koontz O Donnel,"Mc.Graw Hill Intl.Book Co.

2. **Statistical Quality Control:** E.L. Grant and R.S. Leavenworth, 7th edition, McGraw- Hill.

3. **Kotler on Marketing** , Philip D. Kotlar, Copyright © 1999, The Free Press.

4. **Entrepreneurial Development**, S.S. Khanka, S Chand and Company, Revised edition, 2014.

REFERENCE BOOKS

1. Essentials of management, Koontz Weirich,TATA McGraw Hill Intl. Book Co., 7th Edition

2. Management of Organizational Behaviour, Hersey Paul and Kenneth H," PHI

3. Operations management-strategy and analysis, LeeJ.Krajewski and Larry P. Ritzman, Fifth Edition Addison-Wiley

4. Organizational Behaviour, Stephen P Robbins, 9th Edition, Pearson Education Publications, ISBN-81-7808-561-5 2002

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven Full Questions to be set and Five full Questions to be answered.
2. Unit-2, Unit-3 and Unit-4 are compulsory, with one question from each Unit and from Unit-1 and Unit-5: Two questions to be set with choice

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)
(irrespective of portions covered due to whatever might be the reason)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : ADVANCED WELDING PROCESS		
Course Code : ME742	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/ week : 03
Exam Duration: 3 Hrs		Exam Marks : 100

Course objectives:

1. The student gains information on different solid state welding processes.

2. To understand the working principle, weld characteristics and process parameters of high energy beam welding.

3. To understand the working principle, advantages, disadvantages of elctroslag, electrogas welding, thermit welding.

4. To understand the process of thermal cutting of materials, brazing and soldering.

Unit No.	Syllabus	No.of hours
1.	**SOLID STATE WELDING PROCESSES** Friction and friction stir welding, ultrasonic welding, adhesive bonding, diffusion bonding, explosion welding- basic principle, process variables, weld characteristics advantages, limitations and applications	07
2.	**HIGH ENERGY BEAM WELDING PROCESSES** Electron Beam Welding (EBW) - basic principle, equipment details, process characteristics, process variables, advantages, limitations and applications. Laser Beam Welding (LBW) – principle of operation, different laser mediums, advantages, limitations and applications	06
3.	**ELECTRO SLAG AND ELECTRO GAS WELDING** Principle of operation, equipment details, process variations, advantages, limitations and applications. **THERMIT WELDING** Basic principle, thermit mixtures, applications	10
4.	**THERMAL CUTTING** Oxy- Acetylene cutting-basic principle, metal powder cutting, chemical flux cutting, oxygen lancing; Arc cutting- brief introduction to oxygen/air / plasma / metal arc cutting arc cutting and gouging; advantages, limitations and applications of various techniques	06
5.	**BRAZING AND SOLDERING** Introduction, brazing vs. soldering, various techniques, their advantages, limitations and applications; brazing & soldering consumables.	10

	UNDERWATER WELDING Introduction to wet and dry under water welding & cutting. **WELDING IN SPACE** Introduction, welding techniques, difficulties and advantages	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Describe the working principle, process characteristics, advantages, disadvantages and limitations of friction welding, friction stir welding, ultrasonic welding, adhesive boning, explosion welding and diffusion bonding.

2. Describethe mechanism, working principle and process characteristics of high energy beam welding.

3. Demonstrate with the mechanism, working principle and process characteristics of electroslag, electro gas welding and thermit welding, soldering, brazing, underwater welding .

4. Decide best cutting techniques for a particular application and their limitations.

TEXT BOOKS:

1. S.V.Nadkarni, "Modern Arc Welding Technology", Oxford & IBH.

2. R.Little, "Welding Technology, TMH. WELDING CODES AND STANDARDS ME-9111 L T P

REFERENCE BOOKS:

1. H.B.Cary, "Modern Arc Welding Technology", Englewood Cliffs, Prentice Hall.

2. Leonard P Connor, Welding Hand book, Volume I-III, AWS.

3. Metals Hand book , Volume 6, American Society of Metals.

4. Dave Smith, "Welding skills and technology", McGraw Hill.

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-2 and Unit-4are compulsory, with one full question from each Unit.
4. Unit-3 and Unit-5: Two full questions to be set with choice

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	2	3	1	2	1	1	1	1	1	1	0
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : ADVANCED HEAT TRANSFER (CORE ELECTIVE)		
Course Code : ME743	No of Credits : L-T-P-SS 04:00:00:00 =04	No. of lecture hours/ week : 04
Exam Duration: 3 Hrs		Exam Marks : 100
Pre-requisites	Basic & Applied Thermodynamics, Fluid Mechanics, Heat Transfer	

Course objectives:

1. To understand the heat conduction in solids with variable thermal conductivity and heat generation.
2. To solve steady and unsteady heat conduction problems using finite difference method.
3. To derive the differential equation of heat convection and solve problems related to flow over solids of different geometry.
4. To understand the heat transfer by natural convection and analyse the correla-tions for enclosed spaces to solve numerical problems.
5. To explain the phenomena of condensation and boiling and understand the correlations related to them.
6. To understand the mass transfer and different types of mass transfer.

Unit No.	Syllabus	No.of hours
1.	**HEAT CONDUCTION IN SOLIDS** The differential equation of heat conduction, Variable thermal conductivity, Heat generation, Two-dimensional steady state heat conduction, Unsteady state heat conduction processes, The finite difference method for solving steady and unsteady state heat conduction problems, Numericals.	07
2.	**HEAT TRANSFER BY FORCED CONVECTION** The differential equation of heat convection, Laminar and turbulent flow heat transfer in a pipe, The thermal boundary layer, Heat transfer in laminar flow over a flat plate, The integral method, Analogy between heat and momentum transfer, Heat transfer in turbulent flow over a flat plate, Flow across a cylinder, Flow across banks of tubes, Numericals	06
3.	**HEAT TRANSFER BY NATURAL CONVECTION** Introduction, Natural convection heat transfer from a vertical plate, Correlations for a horizontal cylinder and a horizontal plate, Correlations for enclosed spaces, Combined convection, Numericals.	06
4.	**CONDENSATION AND BOILING** Introduction, Film and drop condensation, Film condensation on a vertical plate, Condensation on horizontal tubes, Effect of superheated vapour and of non-condensable gases, Type of boiling, Correlations in saturated pool boiling, Flow boiling, Numericals	10

5.	**MASS TRANSFER** Introduction, Fick's law of diffusion, Steady state mass diffusion in a stationary medium, Diffusion in mixing medium, Convective mass transfer, Analogy between heat and mass transfer, Simultaneous heat and mass transfer, Numericals	10

TEXT BOOKS

1. **A Text Book on Heat Transfer,** S.P. Sukhatme, 4th Edition, Universities Press,2005.

2. **Heat and Mass Transfer,** P.K. Nag, 3rd Edition, Tata McGraw-Hill Publications,2011.

3. **A Course in Heat and Mass Transfer,** Domkundwar, Arora, Domkundwar, DhanpatRai Publications, 2005.

REFERENCE BOOKS

1. **Heat and Mass Transfer**, Cengel,Y.A., and Ghajar, A.J., 4th Edition, McGraw-Hill Publications, 2011.

2. **Principles of Heat and Mass Transfer**,Frank P. Incropera,David P. Dewitt,Theodore L. Bergman, and Adrienne S. Lavine, 7th Edition, Wiley Student Edition, 2013.

e-LEARNING RESOURCES

1. **A Heat Transfer Text Book**, John H Leinard IV and John H Leinard V, 3rd Edition, Phlogiston Press, Cambridge, Massachusetts, USA, 2008.

2. **Heat and Mass Transfer: Mechanical Engineering Handbook**, Kreith, F.,Boehm, R.F., et. al., Frank Kreith (Ed), Boca Raton: CRC Press LLC, 1999.

3. **Fundamentals of Heat and Mass Transfer**, Frank P. Incropera,David P. Dewitt,et. al. Frank P. Incropera (Ed), 6th Edition, John Wiley and Sons, 2007.

4. **e-Journal: Frontiers in Heat and Mass Transfer**,http://www.ThermalFluids Central.org

5. **Videos, Student slides, Handouts, Lecture notes:** http://www.nptel.ac.in

DATA HAND BOOK AND CHARTS

1. **Heat and Mass Transfer Data Hand Book,** C.P. Kothandaraman, S.Subramanyan, New Age International Publishers, 8th Edition, 2014.

2. **Steam Tables with Mollier Diagram: SI Units**, Mahesh M.Rathore,DhanpatRai Publishing Company, 2014.

SYLLABUS COVERAGE FOR CIE

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)

CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Describe conduction and convection heat transfer mechanisms, boiling, condensation and mass transfer.
2. Distinguish the heat and mass transfer modes with examples and illustrations.
3. Sketch and solve problems related to application of conduction, convection, boiling, condensation and mass transfer.
4. Compare and analyse different modes of heat transfer.
5. Derive mathematical expressions and equations to determine the heat and mass transfer rate.
6. Calculate the rate of heat and mass transfer and compute the performance of various heat and mass transfer systems.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	2	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : ENGINEERING TRIBOLOGY (CORE ELECTIVE)		
Course Code : ME751	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/ week : 03
Exam Duration: 3 Hrs		Exam Marks : 100

Course objectives:

1. Describe the basic systems and components.
2. Analyze & Emphasize allied mechanisms.

Unit No.	Syllabus	No.of hours
1.	**INTRODUCTION TO TRIBOLOGY** Properties of oils and equation of flow: Viscosity, Newton's Law of viscosity, Hagen-Poiseuille Law, Flow between parallel stationary planes, viscosity measuring apparatus. Lubrication principles, classification of lubricants	05
2.	**HYDRODYNAMIC LUBRICATION** Friction forces and power loss in lightly loaded bearing, Petroff's law, Tower's experiments, idealized full journal bearings. **Mechanism Of Pressure Development In An Oil Film:** Reynold's investigations, Reynold's equation in two dimensions. Partial journal bearings, end leakages in journal bearing, numerical problems.	06
3.	**Slider / Pad Bearing With A Fixed And Pivoted Shoe** Preliminary design of roller element bearings, Pressure distribution, Load carrying capacity, coefficient of friction, frictional resistance in a pivoted shoe bearing, influence of end leakage, numerical examples	08
4.	**Oil Flow And Thermal Equilibrium Of Journal Bearing** Oil flow through bearings, self-contained journal bearings, bearings lubricated under pressure, thermal equilibrium of journal bearings. **HYDROSTATIC LUBRICATION:** Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing	10
5.	**BEARING MATERIALS** Commonly used bearings materials, properties of typical bearing materials.Introduction to magnetic bearings & foil bearings. **WEAR:** Classification of wear, wear of polymers, wear of ceramic materials, wear measurements, effect of speed, temperature and pressure.	10

	BEHAVIOR OF TRIBOLOGICAL COMPONENTS: Selection, friction, Wear of ceramic materials, wear measurements, effects of speed, temperature and pressure. Tribological measures, Material selection, improved design, surface engineering	

COURSE OUTCOMES: On completion of the course, student should be able to;
1. Distinguish the types of bearings used and categorize them
2. Understand the various lubrication systems
3. Work on need based lubrication and bearing designs.

TEXT BOOKS:

1. Fundamentals of Tribiology , Basu S K., Sengupta A N., Ahuja B. B., , PHI2006

2. Introduction to Tribiology Bearings, Mujumdar B. C., S. Chand company pvt.Ltd 2008.

REFERENCE BOOKS:

1. Theory and Practice of Lubrication for Engineers, Fuller, D., New Yorkcompany 1998

2. Principles and Applications of Tribiology, Moore, Pergamaon press 1998

3. Tribiology in Industries,Srivastava S., S Chand and Company limited, Delhi2002.

4. Lubrication of bearings – Theoretical Principles and Design,RedzimovskayE I., Oxford press company 2000.

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-2 and Unit-3 are compulsory, with one full question from each Unit.
4. Unit-4 and Unit-5: Two full questions to be set with choice

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	2	3	1	2	1	1	1	1	1		0
2	3	3	2	1	2	1	1	1	1	2		1
3	3	3	2	1	2	1	1	1	1	2		1

Strong-3, Medium-2, Weak-1

COURSE TITLE : INDUSTRIAL ROBOTICS (CORE ELECTIVE		
Course Code : ME752	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/ week : 03
Exam Duration: 3 Hrs		Exam Marks : 100

Course objectives:

1. To understand the application of robots in an industry based on its structure
2. To understand the basic function of controllers
3. To analyze the position representation of points on various linkages with respect to other linkages using homogenous transportation matrices
4. To progress robots for pick-place using VAL-II
5. To understand the functions of vision system and applications for inspection in assembly

Unit No.	Syllabus	No.of hours
1.	**INTRODUCTION** **AUTOMATION AND ROBOTICS**: brief history of robotics. Social and economic aspects of robotics, advantages and disadvantages of using robots in industries.Overview of robots present and future applications.Classification and structure of robotic system: Classifications based on geometrical configurations. Wrist and its motions, end effectors and its types, links and joints. **ROBOT DRIVE SYSTEMS**:- Hydraulic, electric and pneumatic drive systems (to study only advantages and disadvantages), resolution, accuracy and repeatability, payload work volume	08
2.	**CONTROL SYSTEMS AND COMPONENTS** Basic control system concepts and models, transformation and block diagram of spring mass system, controllers – ON and OFF, proportional integral, proportional and integral, transient and response to second order system. Robot Actuation and Feedback components: position. Sensors, Actuators	06
3.	**ROBOT ARM KINEMATICS** **KINEMATICS**- Introduction, direct and inverse kinematics, rotation matrix, composite rotation matrix, relation between basic coordinates & rotary coordinates (PTP and CP motions), rotation matrix about an arbitrary axis, Euler angles representation. Ho-mogeneous transformations, links, joints and their parameters. D-H representation. **ROBOT ARM DYNAMICS:** Lagrange – Euler formulations – Joint velocities, kinetic energy , potential energy and equations of a robot manipulator	10
4.	**TRAJECTORY PLANNING** Introduction. General considerations on trajectory planning, joint interpolated trajectories, 4-3-4 trajectory example. Planning of Cartesian path Trajectories Robot programming**:** Introduction, manual teaching, lead through teaching, programming language – Victor Assembly Language- II and simple pallatization program, programming with graphics, storing and operating. Task programs.	10
5.	**SENSORS& VISION SYSTEMS** Internal state sensors, tactile sensors, proximity sensing, range sensing, and force-torque sensors. Elements of computer vi-sion. Sensing and digitizing function in machine vision – im-age devices – lighting techniques – analog to digital signal conversion- sampling - unitization – encoding- image storage. Image processing and analysis, Feature Extraction and Object recognition	05

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Explain the drives and control system required for various applications of robots.
2. To teach Homogeneous transformation, kinematic and dynamic analysis of robots
3. Identify Inverse kinematic and trajectory planning related problems.
4. Demonstrate the robot sensors and object recognition systems.

TEXT BOOKS:

1.Robotics by Fu and Gonsalvez

REFERENCE BOOKS:

1. Industrial Robotics by Mikell P Groover
2. Robotics by Yorenkoren

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-2 and Unit-5 are compulsory, with one full question from each Unit.
4. Unit-3 and Unit-4: Two full questions to be set with choice

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)

CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	0
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : SOLAR ENERGY ENGINEERING (CORE ELECTIVE)		
Course Code : ME753	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/ week : 03
Exam Duration: 3 Hrs		Exam Marks : 100
Pre-requisites	Basic Thermodynamics, Heat Transfer	

Course objectives:

1. To provide opportunity for students to work on multidisciplinary projects.
2. To provide students with a sound foundation to formulate, solve and analyze basic Non – conventional energy problems and prepare them for graduate stud-ies.
3. The objective is to familiarize the students with non-conventional energy sources and allied technological systems for energy conversion.
4. Focus is on solar energy conversion, Wind energy conversion and Bio- mass based energy conversion with their application perspective.
5. This course also serves the objective of imparting the importance of non-conventional energy conversion technologies in the present day energy crisis scenario.

Unit No.	Syllabus	No.of hours
1.	**INTRODUCTION** Energy source: renewable energy sources, renewable energy potential and achievements in India, General characteristics of solar energy; the Sun, solar spectrum, spectral solar impedance. **SOLAR RADIATION AT THE EARTH SURFACE** Solar constant beam, diffuse and global radiation.Solar radiation data of India. Measurement of solar radiation.Pyranometer, pyrheliometer, sunshine recorder (schematic diagram and working principles of devices.)	**06**
2.	**SOLAR RADIATION GEOMETRY** Sun earth angles- latitude, declination, hour angle, zenith, solar altitude angle, surface azimuth angle, solar azimuth angle, Local apparent time, solar time, apparent motion of sun, day length, numerical examples. **SOLAR THERMAL RADIATION DEVICES** Liquid flat plate collectors, solar air heaters, concentrating collectors like cylindrical, parabolic, evacuated tubular collectors	**06**
3.	**STORAGE DEVICES** Sensible heat storage, latent heat storage. Application of solar energy: water heating, space heating, space cooling, active and passive cooling systems. Various power generation methods; Solar furnace, Refrigeration, Distillation, Solar ponds; theory, working principle, operational problems (Sketches, principle of working).	**10**

	SOLAR PHOTOVOLTAIC SYSTEM Introduction, Description, Principles of working of solar cell:- Doping, Fermi level, p-n junction, photovoltaic effect. Photovoltaic Material:- Single crystal solar cell, Poly crystal solar cell, thin film solar cell, I-V characteristic, limits to cell efficiency, Cell temperature factors affecting PV cell performance Current status and Future potential of P.V. cells	
4.	**Performance Analysis Of Liquid Flat Plate Collectors** General description, collector geometry, selective surface (qualitative discussion), basic energy balance equation, stagnation temperature, transmissivity of the cover system, transmissivity-absorptivity product, numerical examples. The overall loss coefficient, correlation for the top loss coefficient, bottom and side loss- coefficient **TEMPERATURE DISTRIBUTION** Temperature distribution between the collectors tubes, collector heat removal factor, collector efficiency factor and collector flow factor, mean plate temperature, instantaneous efficiency (all expression to be provided). Effect of various parameters on the collector performance: Collector orientation, selective surface, fluid inlet temperature, number of covers, dust.	**10**
5.	**SOLAR CONCENTRATORS** Introduction, characteristic parameters: Aperture area, Acceptance angle, absorber area, geometric concentration ratio. **TYPES, CLASSIFICATION, TRACKING** Concentration, Non tracking concentrator. Cylindrical parabolic, Hemispherical Bowl Mirror, V- trough. Tracking Methods:- Three Dimensional Concentrators, Two dimensional concentrators. Materials for concentrators: - Reflecting and Refracting surfaces, receiver cover and surface coating, working fluids, insulation; applications- solar pond/power packs in satellites.	**07**

TEXT BOOKS:

1. Solar Energy- Principles of thermal collection and storage, S.P Sukhatme, TMH.
2. Solar Power Engineering, P. K. Nag THH 2003.

REFERENCE BOOKS:

1. Solar Engineering of thermal processes, Duffie, J.A. and Beckman, W.A., JWS (1991)
2. Solar Energy Utilization – G.D.Rai

SYLLABUS FOR CIE:

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)

CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1		2		3	4	5

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven full Questions to be set.
2. Five full Questions to be answered.
3. Unit-3, Unit-4 and Unit-5 are compulsory, with one full question from each Unit.
4. Unit-1 and Unit-2: Two full questions to be set with choice

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Demonstrate an understanding of the scientific principles of methodology of Non-conventional energy.
2. Acquire working knowledge of different Renewable energy science-related top-ics.
3. Design relative model systems based upon different energy conditions and also Specification of different environmental problems.
4. Apply design methodologies, including open and closed gasification system for all feed materials in biomass gasification
5. Analyze the system related concepts effectively in the wind energy designing.
6. Decide the appropriate procedures to ensure that the working model has developed properly

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	2	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : PROJECT WORK PHASE - I		
Course Code : MEP76	No of Credits : L-T-P-SS 00:00:00:08=00	No. of lecture hours/ week : 00
Exam Duration: NA		Exam Marks : 50

Course objectives:

1. To provide an amicable atmosphere for students to plan
2. To test their learned theory knowledge in an actual working situation
3. To discover the value of work and relish rewards of accomplishment
4. To ensure a professional preparation to the liberal educational goals.

Unit No.	Syllabus	No.of hours
1.	**Definition of the problem**	
2.	**Exhaustive literature survey**	
3.	**Methodology**	

The Project Proposal shall be submitted within 3 weeks from the start of the semester in the prescribed standard format (04 copies) to the HOD, after the certification of the concerned guide and HOD.

Minimum No. of students per batch: 02 Maximum No. of students per batch: 04

CIE Evaluation: Two seminars shall be conducted at the end of 6^{th} and 10^{th} week of the semester.

COURSE OUTCOMES: On completion of the course, student should be able to;
1. Literature review on par with international journal standards
2. Literature gap determination and definition of the problem
3. Scientific Design / Numerical Analysis / Analytical model and interpret them
4. Apply tools / techniques for problem solving and prepare project work

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

AIT/Dean/ /2016-17

Dr Ambedkar Institute of Technology, Bengaluru
(An Autonomous Institution Affiliated to VTU, Belgavi)
Inter Departmental Electives – Odd Semester 2017-18

Sl No	Subject Title	Subject Code	Prerequisite	Depts. For which the course can be offered	Room No	Teaching Dept	No of section
1	Integrated Solid Waste Management	CVE01	Environmental science	All Dept	S108	CV	01
2	Elements of Operations research	MEE01	NIL	All Dept		ME	02
3	Elements of Solar Engineering	MEE02	NIL	All Dept		ME	02
4	Elements of Power plant Engg.,	MEE03	NIL	All Dept		ME	02
5	Product Design and Development	MEE04	NIL	All Dept		ME	01
6	Renewable Energy Sources	EEE01	NIL	All Dept	S110	EE	01
7	Cryptography	ECE01	NIL	CS,IS,TC,EE,EI	C203	ECE	01
8	Automotive Safety Measurements	ECE02	NIL	CS,IS,TC,EE,EI,ME	C209	ECE	01
9	Internet Engineering	TEE01	Computer Networks	CS,IS,EC,EE,EI,ML	C322	TCE	01
10	RTOS	TEE02	NIL	CS,IS,EC,EE,EI,ML	C405	TEC	02
11	Arm Processor	ITE01	Microcontroller	EC,EE,ML,TE,	C404	IT	01
12	Wireless Sensor Networks	CSE01	Basic of Computer N/W	TE,EC,IS,IT	C116 / C119	CSE	01
13	Storage Area Network	CSE02	Basic of Computer N/W	TC, EC,IS,IT	C116 / C119	CSE	01
14	Unix Shell Programming	CSE03	Basic of Computer Language	TC,EC,IS,IT,EE,ME, CV,ML,IEM	C116 / C119	CSE	01
15	Information Systems	ISE02	Computer Fundamentals	CS,EC,EE,ML,TC,IT	D109	ISE	01
16	Medical Imaging Systems	MEL01	NIL	All Dept	302A	ML	01
17	Neural Networks	MEL02	NIL	All Dept	302A	ML	01
18	Engineering Economy	IME01	NIL	All Dept	322A	IEM	01

Dean (Academic) Principal

Copy to 1. Principal W/cs for information
2. All HODs

VIII Semester (2014-15)

Admission Year:2014-18 Academic Year : 2017-18 Semester : Eighth

COURSE TITLE : RAPID PROTOTYPING		
Course Code : ME811	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/ week : 03
Exam Duration: 3 Hrs	CIE+SIE = 100 Marks	Exam Marks : 100

COURSE OBJECTIVES:

1. Describe the manufacturing techniques of rapid prototyping process.
2. Successfully apply the following techniques in rapid prototyping process.
3. Analyze the different Rapid tooling methods
4. Evaluate optimization in Rapid Manufacturing process

Unit No.	Syllabus	No.of hours
1.	**INTRODUCTION:** Need for the compression in product development, history of RP systems, Survey of applications, Growth of RP industry, and classification of RP systems, general steps in producing components using RP technology. **STEREO LITHOGRAPHY SYSTEMS:** Principle, Process parameter, Process details, Data preparation, data files and machine details, Application.	06
2.	**RP PROCESSES:** Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications. FUSION DEPOSITION MODELLING: Principle, Process parameter, Path generation, Applications.	05
3.	**SOLID GROUND CURING:** Principle of operation, Machine details, Applications. Laminated Object Manufacturing: Principle of operation, LOM materials. Process details, application. CONCEPTS MODELERS: Principle, Thermal jet printer, Sander's model market, 3-D printing. GenisysXs printer HP system 5, object Quadra systems, comparisons of different RP technologies.	08
4.	**RAPID TOOLING :** Indirect Rapid tooling, Silicone rubber tooling, Aluminum filled epoxy tooling, Spray metal tooling, Cast Kirksite, 3Q Keltool, etc. Direct Rapid Tooling Direct. AIM. RAPID TOOLING**:** Quick Cast process, Copper polyamide, Rapid Tool, DMLS, Prometal, Sand casting tooling, Laminate tooling soft Tooling vs. Hard tooling	10

5.	**SOFTWARE FOR RP:** STL files, Overview of Solid view, Magics, Imics, Magic communicator, etc. Internet based software, Collaboration tools, factors influencing accuracy. Data preparation errors, Part building errors, Error in finishing, Influence of build orientation.	10

COURSE OUTCOMES:

1. Describe fundamentals of Rapid Prototyping technology
2. Classify RP techniques for preparing prototypes for a given product.
3. RP techniques such as SLA, SLS, FDM, SGC, LOM based on their applicability, materials used, and advantages.
4. Apply rapid tooling technique for a specified product.
5. Create RP models using software tools.
6. Analyze advanced RP techniques for their suitability and merits.

TEXT BOOKS:

1. Stereo Lithography and other RP & M Technologies, Paul F. Jacobs: SME, NY 1996.
2. Rapid Manufacturing,Flham D.T &Dinjoy S.S Verlog London 2001.

REFERENCE BOOKS:

1. Rapid Prototyping, Terry Wohler's Report 2000" Wohler's Association 2000.
2. Rapid Prototyping Materials, Gurumurthi, IISc Bangalore.
3. Rapid Automated, Lament wood. Indus press New York

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven Full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-2 and Unit-3 are compulsory, with one question from each Unit.
4. Unit-4 and Unit-5: Two questions to be set with choice.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)

CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

(Irrespective of portions covered due to whatever might be the reason)

COURSE TITLE : INTERNAL COMBUSTION ENGINES (CORE ELECTIVE)		
Course Code : ME812	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/ week : 03
Exam Duration: 3 Hrs		Exam Marks : 100
Pre-requisites	Basic and Applied Thermodynamics	

Course objectives:

1. To understand the basic principle of thermodynamic process

2. To understand the basic components and structure of IC engines (both SI and CI engines), process parameters

3. Understanding the performance of the engine, combustion and exhaust param-eters

Unit No.	Syllabus	No.of hours
1.	**CARBURETION** Introduction, Definition, Factors affecting carburetion, Air-fuel mixture, Mixture requirement, Principle of carburetion, Simple carburetor, Calculation of air-fuel ratio, Essential parts of a carburetor, Compensating devices, Additional systems in modern carburetors, Types of carburetors, Automobile carburetors, Altitude compensation, Numericals.	07
2.	**INJECTION SYSTEMS** Introduction, Functional requirements, Classification, Fuel feed pump, Injection pump, Injection pump governor, Mechanical and pneumatic governor, Fuel injector, nozzle, Injection in SI engine, Numerical problems, Gasoline injection, Electronic fuel injection system, Multipoint fuel injection system, Functional divisions of MPFI system, Electronic control system, Injection timing, Group gasoline and electronic diesel injection system, Injection control.	06
3.	**COMBUSTION AND COMBUSTION CHAMBERS** Introduction, Homogeneous and heterogeneous mixture, Combustion and its stages in SI and CI engine, Flame front propagation, Factors influencing the flame speed, Rate of pressure rise, Abnormal combustion, Factors affecting the delay period, Adiabatic flame temperature, Phenomenon of knock in SI and CI engine, Effect of engine variable in knock, Combustion chambers for SI and CI engine, Combustion and its stage in CI engine, Comparison of knock in SI and CI engine.	06
4.	**Measurement And Testing Of Performance Parameters** Introduction, Measurement of friction power, indicated power, brake power, fuel and air consumption, Speed, Exhaust and coolant temperature, Emission, Noise and Combustion parameters; Engine efficiencies, Performance characteristics, Factors affecting performance, Methods of improving engine performance, Heat balance, Performance maps, Analytical method of performance estimation, Numericals.	10
5.	**NON CONVENTIONAL ENGINES** Introduction, Construction, working principle and design of CRDI engine, Dual fuel and multi-fuel engine, Free piston engine, Gasoline Direct Injection engine, HCCI engine, Lean burn engine, Stirling engine, Stratified charge engine, VCR engine and Wankel engine	10

TEXT BOOKS

1. Internal Combustion Engines, V. Ganesan, Tata Mc-Graw Hill Publications, 4th Edition, 2012.

2. Internal Combustion Engines, M. L. Mathur and R. P. Sharma, Dhanpat Rai Publications, 2014.

REFERENCE BOOKS

1.Internal Combustion Engine Fundamentals, John B. Heywood, Mc-GrawHill Education India Limited, 2011.

2. Engineering Fundamentals of the Internal Combustion Engines, WillardW. Pulkrabek. Pearson Education, 2nd Edition, 2015.

3. A Text Book of Internal Combustion Engines, R.K. Rajput, Laxmi Publish-ers, 2007.

SYLLABUS FOR CIE

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)

CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.

2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.

3. Each question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Describe the carburetion and combustion processes with examples.
2. E xplain the fuel injection systems in IC engines.
3. Sketch the combustion chambers in IC engines with illustrations.
4. Evaluate the performance parameters of IC engines.
5. Derive the performance characteristics of engines.
6. Summarize the non-conventional engines in the context of modern developments.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

Admission Year:2014-18 Academic Year : 2017-18 Semester : Eighth

COURSE TITLE : ENGINEERING ECONOMICS		
Course Code : ME813	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/ week : 03
Exam Duration: 3 Hrs	CIE+SIE = 100 Marks	Exam Marks : 100

COURSE OBJECTIVES:

1. Helping decision making
2. Calculation of interest
3. Arriving at break-even point
4. Feasibility study from economic point of view
5. Preparation of budget
6. Understanding financial statements
7. Arriving at the product cost

Unit No.	Syllabus	No.of hours
1.	**INTRODUCTION:** Elements of Engineering Economics, Engineering Decision- Makers, Engineering and Economics, Problem solving and Decision making, Intuition and Analysis, Tactics and Strategy. Engineering Economic Decision, Maze. Law of demand and supply, Law of returns, Interest and Interest factors: Interest rate, Simple interest, Compound interest, Cash - flow diagrams, Personal loans and EMI Payment, Exercises and Discussion	**10**
2.	**PRESENT-WORTH COMPARISONS:** Conditions for present worth comparisons, Basic Present worth comparisons, Present-worth equivalence, Net Present-worth, Assets with unequal lives, infinite lives, Future-worth comparison, Pay-back comparison, Exercises, Discussions and problems. **RATE-OF-RETURN CALCULATIONS AND DEPRECIATION:** Rate of return, Minimum acceptable rate of return, IRR, IRR misconceptions, Cost of capital concepts. Causes of Depreciation, Basic methods of computing depreciation charges, Tax concepts, corporate income tax.	**12**
3.	**ESTIMATING AND COSTING:** Components of costs such as Direct Material Costs, Direct Labor Costs, Fixed Over-Heads, Factory cost, Administrative Over-Heads, First cost, Marginal cost, Selling price, Estimation for simple components.	**10**

4.	**INTRODUCTION, SCOPE OF FINANCE, FINANCE FUNCTIONS:** Statements of Financial Information: Introduction, Source of financial information, Financial statements, Balance sheet, Profit and Loss account, relation between Balance sheet and Profit and Loss account. Simple Numericals. **FINANCIAL RATIO ANALYSIS:** Introduction, Nature of ratio analysis, Liquidity ratios, Leverage ratios, Activity ratios, Profitability ratios, Evaluation of a firm's earning power. Comparative statements analysis. Simple Numericals.	12
5.	**FINANCIAL AND PROFIT PLANNING:** Introduction, Financial planning, Profit planning, Objectives of profit planning, Essentials of profit planning, Budget administration, type of budgets, preparation of budgets, advantages, problems and dangers of budgeting. Introduction to Bench Marking of Manufacturing Operation.	10

COURSE OUTCOMES:

At the end of the course the student will be able to;
1. Take the right financial decision
2. Help in calculating the financial factors
3. Arrive at feasibility study of the project
4. Train to prepare the budget

TEXT BOOKS:

1.Engineering Economy, Riggs J.L., , McGraw Hill, 2002

2.Engineering Economy, Thuesen H.G. PHI , 2002

REFERENCE BOOKS:

1. Engineering Economy, Tarachand, 2000.
2. Industrial Engineering and Management, OP Khanna, Dhanpat Rai & Sons. 2000
3. Financial Mangement, Prasanna Chandra, TMH, 2004
4. Finacial Management, IM PANDEY, Vikas Publisahing House, 2002

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven Full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-3 and Unit-5 are compulsory, with one question from each Unit.
4. Unit-2 and Unit-4: Two questions to be set with choice.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)
(Irrespective of portions covered due to whatever might be the reason)

COURSE TITLE : COMPUTER INTEGRATED MANUFACTURING (CORE ELECTIVE)		
Course Code : ME821	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/ week : 03
Exam Duration: 3 Hrs		Exam Marks : 100

COURSE OBJECTIVES:

1. As a method of manufacturing, three components distinguish CIM from other manufacturing methodologies:

2. Means for data storage, retrieval, manipulation and presentation;

3. Mechanisms for sensing state and modifying processes;

4. Algorithms for uniting the data processing component with the sensor/modification component.

5. CIM is an example of the implementation of information and communication technologies (ICTs) in manufacturing.

6. CIM implies that there are at least two computers exchanging information, e.g. the controller of an arm robot and a micro-controller of a CNC machine.

7. Some factors involved when considering a CIM implementation are the production volume, the experience of the company or personnel to make the integration, the level of the integration into the product itself and the integration of the production processes. CIM is most useful where a high level of ICT is used in the company or facility, such as CAD/CAM systems, the availability of process planning and its data.

Unit No.	Syllabus	No.of hours
1.	**COMPUTER INTEGRATED MANUFACTURING SYSTEMS** Introduction, Automation definition, Types of automation, Group Technology, processing in manufacturing, Production concepts, Mathematical Models-Manufacturing lead time, production rate, components of operation time, capacity, Utilization and availability, Work-in-process, WIP ratio, TIP ratio, Problems using mathematical model equations. Automation Strategies, problems.l	06
2.	**HIGH VOLUME PRODUCTION SYSTEM** Introduction Automated flow line-symbols, objectives, Work part transport-continuous, Intermittent, synchronous, Pallet fixtures, Transfer Mechanism-Linear-Walking beam, roller chain drive, Rotary-rack and pinion, Rachet & Pawl, Geneva wheel, Buffer storage, control functions-sequence, safety, Quality, Automation for Machining operation, problems.	06

3.	**ANALYSIS OF AUTOMATED FLOW LINE & LINE BALANCING** General terminology and analysis, Analysis of Transfer Line without storage upper bound approach, lower bound approach and problems, Analysis of Transfer lines with storage buffer, Effect of storage, buffer capacity with Simple problem, Partial automation-with numerical problems. **MINIMUM RATIONAL WORK ELEMENT:** Work station process time, Cycle time, precedence constraints. Precedence diagram, Balance delay methods of line balancing-largest Candidate rule, Kilbridge and Westers method, Ranked positional weight method, Numerical problems covering above methods and computerized line balancing.	**10**
4.	**AUTOMATED ASSEMBLY SYSTEMS** Design for automated assembly systems, types of automated assembly system, Parts feeding devices-elements of parts delivery system-hopper, part feeder, Selectors, feedback, escapement and placement analysis of Multi station Assembly Machine analysis of single station assembly. **AUTOMATED GUIDED VEHICLE SYSTEM**: Introduction, Vehicle guidance and routing, System management, Quantitative analysis of AGV's with numerical problems and application.	**10**
5.	**COMPUTERIZED MANUFACTURING PLANNING SYSTEM** Introduction, Computer Aided Process Planning, Retrieval types of process planning, Generative type of process planning, Material requirement Planning, Fundamental concepts of MRP inputs to MRP, Capacity planning, ERP. Shop Floor Control: Factory, Data Collection System, Automatic identification system. **COMPUTER AIDED QUALITY CONTROL:** Contact inspection methods, Non-Contact inspection methods, Co-ordinate measuring machine.	**07**

COURSE OUTCOMES:

1. Integration of components from different suppliers: When different machines, such as CNC, conveyors and robots, are using different communications protocols (In the case of AGVs, even differing lengths of time for charging the batteries) may cause problems.

2. The higher the degree of automation, the more critical is the integrity of the data used to control the machines. While the CIM system saves on labor of operating the machines, it requires extra human labor in ensuring that there are proper safeguards for the data signals that are used to control the machines.

3. Process control: Computers may be used to *assist* the human operators of the manufacturing facility, but there must always be a competent engineer on hand to handle circumstances which could not be foreseen by the designers of the control software.

TEXT BOOKS:

1. Automation, Production system & Computer Integrated manufacturing, M. P. Groover” Person India, 2007 2nd edition.

2. Principles of Computer Integrated Manufacturing, S. Kant Vajpayee, PHI.

REFERENCE BOOKS:

1. Automation, Production system & Computer Integrated manufacturing, M. P. Groover, PHI Publications, 15 Edition.

2. Computer Integrated Manufacturing, J. A. Rehg & Henry. W. Kraebber.

3. CAD/CAM by Ibrahim Zied, Tata McGraw Hill, Fourth Reprint, 2008.

4. CAD/CAM by Mikell P Groover, Emory W Zimmers Jr, PHI Publications.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven Full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-2 and Unit-5 are compulsory, with one question from each Unit.
4. Unit-3 and Unit-4: Two questions to be set with choice.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)
(Irrespective of portions covered due to whatever might be the reason)

COURSE TITLE : COMPUTATIONAL FLUID DYNAMICS(CORE ELECTIVE)		
Course Code : ME822	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/ week : 03
Exam Duration: 3 Hrs		Exam Marks : 100
Pre-requisites	Basic Thermodynamics, Fluid Mechanics, Heat Transfer	

Course objectives:

1. To understand the fundamentals of CFD and fluid flow equations in conservation forms.
2. To explain finite difference method and approximations used in this method.
3. To understand the finite volume and finite element methods of discretizing the partial differential equations.
4. To know the various methods of grid generation and solving the differential equations.
5. To understand the concept of viscous compressible flow and related equations.

Unit No.	Syllabus	No.of hours
1.	**INTRODUCTORY CONCEPTS** Introduction: Conservation equations; Mass, momentum and energy equations; Conservative forms of the equations and general description; Classification and Overview of Numerical Methods: Classification into various types of equations – parabolic, elliptic and hyperbolic; Boundary and initial conditions; Overview of numerical methods	07
2.	**FINITE DIFFERENCE METHOD** Introduction, finite difference approximations, Taylor series expansion, polynomial fitting, approximation of boundary conditions, applications to conduction and advection-diffusion problems	06
3.	**FINITE VOLUME AND FINITE ELEMENT METHODS** Finite Volume Method: Basic methodology, finite volume discretization, approximation of surface and volume integrals, interpolation methods – central, upwind and hybrid formulations and comparison for convection-diffusion problem; Finite Element Method: Introduction to Rayleigh-Ritz, Galerkin and least square methods, interpolation functions, one and two dimensional elements, applications.	06
4.	**GRID GENERATION AND SOLUTION METHODS** Introduction; Classification; Principles of structured mesh generation; Structured grid generation techniques; Unstructured mesh generation; Adaptive mesh generation; Solution of finite difference equations, iterative methods, matrix inversion methods, ADI method, operator splitting, fast Fourier transform, applications; Time integration Methods: Single and multilevel methods; predictor-corrector methods; stability analysis; Applications to transient conduction and advection-diffusion problems	10
5.	**VISCOUS COMPRESSIBLE FLOW** Navier-Stokes Equations: Explicit and implicit methods; SIMPLE type methods; fractional step methods; Phase Change Problems: Different approaches for moving boundary, variable time step method, enthalpy method; Turbulence modeling: Reynolds averaged Navier-Stokes equations, RANS modeling, DNS and LES.	06

TEXT BOOKS:

1. **Computational Fluid Dynamics: The Basics with Applications,** John D.Anderson, Jr., McGraw-Hill International Editions, 1995.

2.**Computational Fluid Flow and Heat Transfer,** K. Muralidhar andT.Sundararajan (Editors), 2nd Edition, Narosa Publishing House, 2003.

3.**Computational Fluid Dynamics: An Introduction**, John F. Wendt (Editor), Springer (India) Pvt. Ltd., 3rd Edition, 2007.

REFERENCE BOOKS:

1. **Computational Fluid Methods for Fluid Dynamics**, J.H. Ferziger and M.Peric, Springer (India) Pvt. Ltd., 3rd Edition, 2002.

2. **Introduction to Computational Fluid Dynamics**, PradipNiyogi, S.K.Chakrabartty M.K. Laha, Pearson Education, 2011.

3. **Numerical Heat Transfer and Fluid Flow**, Suhas V. Patankar, Hemisphere Publishing Corporation, 1980.

e-LEARNING RESOURCES

1. **Videos, Lecture notes:** http://www.nptel.ac.in

SYLLABUS FOR CIE:

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)

CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Describe the different flow models, physical boundary conditions and governing equations suited for CFD.
2. Illustrate the applications of finite differences in partial differential equations with examples.
3. Sketch and explain the structured, unstructured and adaptive meshes used in the CFD analysis.
4. Compare and differentiate the various CFD techniques used in the finite volume method.
5. Derive expressions of governing equations for viscous and inviscid flows.
6. Relate the various modeling, mesh generation and CFD techniques used in vis-cous and inviscid flows.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	2	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : SMART MATERIALS		
Course Code : ME823	No of Credits : L-T-P-SS 03:00:00:00 =03	No. of lecture hours/ week : 03
Exam Duration: 3 Hrs	CIE+SIE = 100 Marks	Exam Marks : 100

COURSE OBJECTIVES:

1. The aim of this COURSE is to integrate research results with curriculum development for the benefit of students in physics, materials science and engineering, civil and structural engineering, mechanical and aerospace engineering, industrial and systems engineering, as well as electrical and electronic engineering.

2. The fundamentals of smart materials, devices and electronics, in particular those related to the development of smart structures and products;

3. The skills, knowledge and motivation in the design, analysis and manufacturing of smart structures and products

Unit No.	Syllabus	No.of hours
1.	**INTRODUCTION:** Characteristics of composites and ceramics materials, Dynamics and controls, concepts, Electro-magnetic materials, micro sensors and shape memory alloys-processing and characteristics. **SENSING AND ACTUATION:** Principles of electromagnetic, acoustics, chemical and mechanical sensing and actuation, Types of sensors, applications, compatibility. writer conventional and advanced materials, data acquisition, principals and characterization.	**10**
2.	**CONTROL DESIGN:** Design of shape memory alloys, Types of MR fluids, Characteristics and application, principals of MR fluid value designs, Magnetic circuit design, MR Dampers, Design issues. **OPTICS AND ELECTROMAGNETIC:** Principles of optical fiber technology, characteristics of active and adaptive optical system and components, design and manufacturing principles	**10**
3.	**STRUCTURES:** Principles of drag and turbulence control through smart skins, applications in environment such as aerospace and transportation vehicles, manufacturing, repair and maintainability aspects, intelligent systems.	**12**

	CONTROLS: Principles of structural acoustic control, distributed, analog and digital feed back controls, Dimensional implications for structural control.	
4.	**PRINCIPLES OF VIBRATION AND MODAL ANALYSIS:** PZT Actuators, MEMS, Magnetic shape Memory Alloys, Characteristics, Applications.	10
5.	**INFORMATION PROCESSING:** Neural Network, Data Processing, Data Visualization and Reliability – Principles and Application domains.	10

COURSE OUTCOMES:

On completion of this COURSE, students should be able to:

(1) Understand the physical principles underlying the behavior of smart materials;

(2) understand the engineering principles in smart sensor, actuator and transducer technologies;

(3) use principles of measurement, signal processing, drive and control techniques necessary to developing smart structures and products; and

(4) Appreciate and suggest improvement on the design, analysis, manufacturing and application issues involved in integrating smart materials and devices with signal processing and control capabilities to engineering smart structures and products

TEXT BOOKS:

1. Analysis and Design', A. V. Srinivasan, 'Smart Structures –Cambridge University Press, New York, 2001, (ISBN : 0521650267)

2. Smart Materials and Structures', M V Gandhi and B S Thompson Chapmen & Hall, London, 1992 (ISBN : 0412370107)

REFERENCE BOOKS:

1. Smart Materials and Structures', Banks HT, RC Smith, Y Wang, Massow S A, Paris 1996.

2. G P Gibss' Adaptive Structures', Clark R L, W R Saunolers, Jhon Wiles and Sons, New York, 1998

3. An introduction for scientists and Engineers', EsicUdd, Optic Sensors :Jhon Wiley & Sons, New York, 1991 (ISBN : 0471830070).

SCHEME OF EXAMINATION (Question Paper Pattern)

1. SEVEN full questions to be set
2. FIVE full questions to be answered
3. Questions from Unit 1, Unit 2 and Unit 5 are COMPULSORY
4. TWO questions with CHOICE from Unit 3 and Unit 4.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)
(irrespective of portions covered due to whatever might be the reason)

COURSE TITLE : COMPUTER AIDED MODELING AND ANALYSISLABORATORY		
Course Code : MEL83	No of Credits : L-T-P-SS 00:00:02:00 =01	No. of lecture hours/ week : 05
Exam Duration: 3 Hrs		Exam Marks : 50

Course objectives:

1. To be able to understand and handle design problems in systematic manner
2. To gain practical experience in 2D drafting and 3D modeling software systems.
3. To be able to apply CAD in real life applications.
4. 4.To be able to understand meaning and Usefulness of FEM
5 .To be able to understand Various software used to solve the practical problems

Unit No.	Syllabus	No.of hours
1.	**Study of a FEA package and modeling stress analysis of** a. Bars of constant cross section area, tapered cross section area and stepped bar b. Trusses – (Minimum 2 exercises) c. Beams – Simply supported, cantilever, beams with UDL, beams with varying load etc (Minimum 6 exercises)	13
2.	**Stress analysis of** a) Stress analysis of a rectangular plate with a circular hole b) Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions(Minimum 4 exercises) c) Dynamic Analysis 1) Fixed – fixed beam for natural frequency determination 2) Bar subjected to forcing function Fixed – fixed beam subjected to forcing function	13

REFERENCE BOOKS:

1. A first course in the Finite element method, Daryl L Logan, Thomason, 3rd Ed.
2. Fundaments of FEM, Hutton – McGraw Hill, 2004
3. Finite Element Analysis, George R. Buchanan, Schaum Series

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2
UNIT	1	2

SCHEME OF EXAMINATION (SEE)

SI. No.	Particulars	Max. Marks	Break Up of Max. Marks		
			Write Up	Conduction of experiment / Modelling Analysis	Conduc Expected Out Putt- Results (Different displacement, BM, Stress, Strain results. Etcand Plotting deformation
1.	**Unit-1: Minor Experiment** (Any ONE frzzom the list of experiments and it is purely individual Experiment) Q1	15	05	05	05
2.	**Unit-2: Major Experiment** (Any ONE Experiment from the list of experiments and it is a Group Experiment) Q2	25	05	10	10
3.	**Viva Voce**	10	-	-	-
	TOTAL MARKS	50	10	25	15

? Two Full Questions to be set.

? Students shall be to be answered two full Questions.

? Each question(Experiments contains different Marks and it is clearly mentioned in the above table)

? Chaning of Experiments is not allowed from any unite if changing of experiments allowed 50% marks will be deducted.

? Viva Voce is compulsory

COURSE OUTCOMES: On completion of the course, student should be able to

1. Explore the Techniques of 2D and 3D Compter Aided Design (CAD)

2. Elaborate the applications and limitations of different Auto CAD, Micro Station, CATIA, Pro- E,I-DEAS,ExistingFEA software' (ANSYS, NISA, CAEFEM, Abaqus, Msc-Nastran, Optistruct / Radioss, Comsol-Multiphysics system types and ther applications

3. Students will be able to solve a stress analysis problem theoretically, compare the same with results of the software and able to understand the importance of theoretical calculations.

4. Students will be able to assign the different elemet types, properties and also material models to the structure being analyzed. and also students will be able to carry out static, dynamic thermal analysis using ansys to get required Output results.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	2	2	3	3	2	3	3	1	2
2	2	3	3	2	2	1	3	2	3	3	3	2
3	3	3	3	2	3	2	3	1	3	2	3	2
4	3	3	2	2	3	2	3	1	2	2	3	3

Strong-3, Medium-2, Weak-1

Course Title : CONTROL ENGINEERING LABORATORY.		
Course Code : MEL84	No of Credits : 01	No. of lecture hours/ week : 02
Exam Duration: 3 Hrs	CIE Marks : 50	Exam Marks : 50

Course objectives:

1. To understand the basics of control system.
2. To control the heat flow rate and temperature in a tank.
3. To determine effectiveness of PID controller in heating tanks
4. To analyse the control action on the liquid levels in tanks.
5. To control the speed of DC motor

Unit No.	Syllabus	No.of hours
1.	**Basics and heated tank** a) No control heated tank b) Bump less transfer heated tank c) General transfer function d) Anti windup heated tank e) PID standard temperature control of heated tank f) Cascade temperature control of heated tank.	**06**
2.	**Liquid level control** a) Manual level control b) PID standard level control in chip tank c) PID discrete General transfer function d) Feed forward liquid level control in single tank. e) Feed forward liquid level control in double tank	**07**
3.	**Speed control of DC motor** a) Step test b) Set point weighing c) Position and step test d) Speed integral control e) PI implementation f) PID position implementation	**07**
4.	**Magnetic levitation** a) On-off control b) P- control c) Transient response d) PD control for desired pole placement f) PD control for desired transient response	**06**

COURSE OUTCOMES:

1. Evaluate thermal control action and effectiveness of PID control.
2. Plot the characteristic graphs to analyse of liquid level control.
3. Develop motors speed controls as required in industries.
4. Evaluate and optimise the magnetic levitation system.

SCHEME OF EXAMINATION:

One Question from Unit – 1 or 2 - 15 Marks (05 Write up +10)

One Question from Unit – 3 or 4 - 25 Marks (05 Write up +20)

Viva-Voce - 10 Marks

Total - 50 Marks

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : SUBJECT SEMINAR		
Course Code : MES85	No of Credits : L-T-P-SS 00:00:04:00 =02	No. of lecture hours/ week : 04
Exam Duration: 3 Hrs		Exam Marks : 50

COURSE OBJECTIVES:

1. To equip students for making a technical presentation based on a thorough re-search review on any contemporary area of Engineering and Management fields
2. Offering the student an opportunity to interact with faculty and peer group and to build the ability to making independent presentation.

Unit No.	Syllabus	No.of hours
1.	Seminar shall be presented during 8th / 9th week of the semester in the department before the Departmental Evaluation Commit-tee constituted by HOD.	24
2.	The seminar marks are to be awarded by the committee.	14
3.	Students shall submit the seminar report in the prescribed standard format.	14

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Conduct literature survey on a current topic based on peer reviewed literature
2. Identify research gap in the literature
3. Develop methodologies to resolve the identified problem(s)
4. Develop presentation slides / report arranging the material coherently
5. Present and discuss the topic with clarity and confidence and submit the report
6. Summarize the presentation and identify scope for further work

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	2	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

COURSE TITLE : PROJECT WORK PHASE – II		
Course Code : MEP86	No of Credits : L-T-P-SS 02:00:08:04=12	No. of lecture hours/ week : 10
Exam Duration: 3 Hrs		Exam Marks : 100

COURSE OBJECTIVES:

1. To provide an opportunity and atmosphere in which students may test theory learned in the classroom in an actual working situation and discover the value of work and the rewards of accomplishment

2. To insure a natural transition to the higher level of professional preparation as a complement to the liberal education goals of the Institution.

Unit No.	Syllabus	No.of hours
1.	Analysis based on type of problem.	30
2.	Conclusions, scope for further work.	90
3.	References.	10

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Perform literature review on par with international journal standards
2. Identify literature gap and define the problem
3. Design Experiments scientifically / Perform Numerical Analysis / Develop Analyti-cal models
4. Interpret the Experimental / Numerical / Analytical Results
5. Apply advanced tools / techniques for solving the problem
6. Prepare quality document of project work

CIE EVALUATION: Two presentations shall be conducted at the end of 6^{th} and 10^{th} week of the semester. The Project Report shall be submitted in the prescribed standard format (04 copies) to the HOD, after the certification of the concerned guide and HOD.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	2	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2015-16 ACADEMIC YEAR: 2018-19

SEMESTER : SEVENTH

COURSE TITLE : CONTROL ENGINEERING		
Sub Code: ME71	**No of Credits : L-T-P-SS 04:00:00:00 =04**	**No. of lecture hours/week : 04**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 100**
Pre-requisites	**Engineering mathematics**	

COURSE OBJECTIVES:

1. Model the mechanical systems through differential equations.
2. Analyze frequency response characteristics of control systems.
3. Construct root locus, bode plots and Nyquist plots
4. Deduction of block Diagrams and signal flow systems.
5. Emphasize on transient characteristics and response of the systems and Routh-Hurwitz criteria.

#	CONTENTS	h
UNIT-1	**MECHANICAL CONTROL SYSTEMS**	**08**
	Introduction to the Concept of automatic controls, open loop and closed loop control systems, concepts of feedback, requirements of an ideal control system. Mathematical models**:** Transfer function models, models of mechanical systems, feed forward systems with examples. **FREQUENCY RESPONSE ANALYSIS** Polar plots, Nyquist stability criterion, Stability analysis, gain margin and phase margin.	
UNIT-2	**FREQUENCY RESPONSE ANALYSIS USING BODE PLOTS**	**10**
	Bode attenuation diagrams, stability analysis using bode plots, simplified bode diagrams.	
UNIT-3	**ROOT LOCUS PLOTS**	**10**
	Root Loci; Definition, general rules for constructing and analysis using root locus plots	
UNIT-4	**BLOCK DIAGRAMS AND SIGNAL FLOW GRAPHS FREQUENCY RESPONSE**	**12**
	Transfer Functions definition, function, blocks representation of systems elements, reduction of block diagrams, signal flow graphs: Mason's gain formula.	
UNIT-5	**TRANSIENT AND STEADY STATE RESPONSE ANALYSIS:**	
	Introduction, first order and second order system response to step, ramp and impulse inputs, concepts of time constant and its importance in speed of response. System stability: Routh's-Hurwitz criterion; types of controllers- proportional, integral proportional integral, proportional integral differential controllers.	**12**

TEXT BOOKS:

1. **Modern Control Engineering,** Katsuhiko Ogatta, Pearson Education,2004.
2. **Control Systems Principles and Design,** M. Gopal, TMH,2000.

REFERENCE BOOKS:

1. **Modern Control Systems**, Richard.C.Dorf and Robert. H. Bishop, Addison Wesley,1999
2. **System dynamics & control**, Eronini-Umez,Thomson Asia pte Ltd. Singapore, 2002.
3. **Feedback Control System**, Schaum's series. 2001.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)

CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Describe fundamentals of control elements
2. Analyze system stability through root locus and Bode plots.
3. Develop mathematical models of different mechanical and electrical systems.
4. To understand the Block Diagram and Signal flow graphs.
5. Analyze steady state and transient response of first order and second order systems.

MAPPING OF COs WITH POs

COs/POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2015-16 ACADEMIC YEAR: 2018-19
SEMESTER : SEVENTH

COURSE TITLE : HYDRAULICS AND PNEUMATICS		
Sub Code: ME72	**No of Credits : L-T-P-SS 04:00:00:00 =04**	**No. of lecture hours/week : 04**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 100**
Pre-requisites	**Fluid mechanics, Applied thermodynamics**	

COURSE OBJECTIVES:

1. Impart knowledge of mathematics, basic and applied sciences.
2. Ability to identify, formulate and solve mechanical engineering problems based on data interpretation, design, experiment and analysis of results.
3. Learn effective engineering communication.
4. Ability to work in teams on multi-disciplinary projects in industry and research organizations.
5. Develop awareness of the ethical, professional and environmental implications of work in a global and societal context.

#	CONTENTS	h
UNIT-1	**INTRODUCTION**	**08**
	INTRODUCTION TO HYDRAULIC POWER Definition of hydraulic system, advantages, limitations, applications, Pascal's law, structure of hydraulic control system, problems on Pascal's law. **PUMPS** Classification, pumping theory of positive displacement pumps, construction and working of gear pumps, vane pumps, piston pumps, fixed and variable displacement pumps, pump performance characteristics, pump selection factors.	
UNIT-2	**HYDRAULIC ACTUATORS AND MOTORS**	**08**
	Classification cylinder and hydraulic motors, linear hydraulic actuators [cylinders], single and double acting cylinder, mechanics of hydraulic cylinder loading, cushioning, special types of cylinders. **CONTROL COMPONENTS IN HYDRAULIC SYSTEMS** Classification of control valves, directional control valves-ANSI Symbolic representation, constructional features of poppet, sliding spool, rotary type valves solenoid and pilot operated DCV, shuttle valve, check valves, pressure control valves - types, direct operated types and pilot operated types. Flow control valves - compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated pressure and temperature compensated FCV, symbolic representation.	
UNIT-3	**HYDRAULIC CIRCUIT ANALYSIS**	**08**
	Control of Single and double acting hydraulic cylinder, regenerative circuit, pump unloading circuit, double pump hydraulic system, counter balance valve application,	

	hydraulic cylinder sequencing circuits, automatic cylinder reciprocating system, locked cylinder using pilot check valve, cylinder synchronizing circuit using different methods, factors affecting synchronization, speed control of hydraulic motors, safety circuit, accumulators, types, construction and applications with circuits.	
UNIT-4	**INTRODUCTION TO PNEUMATIC CONTROL**	**14**
	Definition of pneumatic system, advantages, limitations, applications, Choice of working medium. Characteristic of compressed air. Structure of Pneumatic control System, fluid conditioners and FRL unit. **PNEUMATIC ACTUATORS** Linear cylinder - types, conventional type of cylinder r- working, end position cushioning, seals, mounting arrangements- applications. Rod - less cylinders types, working, advantages, rotary cylinders- types construction and application, symbols. **COMPRESSED AIR** Production of compressed air- preparation of compressed air-driers, filters, regulators, lubricators, distribution of compressed air piping layout.	
UNIT-5	**PNEUMATIC CONTROL VALVES**	**14**
	DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve, quick exhaust valve, time delay valve, shuttle valve, twin pressure valve, symbols. simple pneumatic control: direct and indirect actuation pneumatic cylinders, speed control of cylinders - supply air throttling and exhaust air throttling and exhaust air throttling. **SIGNAL PROCESSING ELEMENTS** Use of Logic gates - OR and AND gates in pneumatic applications. Practical Examples involving the use of logic gates, Pressure dependant controls- types - construction - practical applications, Time dependent controls principle. Construction, practical applications. **ELECTRO- PNEUMATIC CONTROL** Principles - signal input and output, pilot assisted solenoid control of directional control valves, relay and contactors. Control circuitry for simple signal cylinder application.	

TEXT BOOKS:

1. **"Fluid Power with Applications",** Anthony Esposito**,** Sixth edition, Pearson Education, Inc, 2000.
2. **'Pneumatics and Hydraulics',** Andrew Parr, Jaico Publilishing Co.

REFERENCE BOOKS:

1. **'Oil Hydraulic systems', Principles and Maintenance** S. R. Majurr, Tata McGraw Hill Publishing Company Ltd. - 2001
2. **'Industrial Hydraulics',Pippenger, Hicks"** McGraw Hill, New York

3. **'Hydraulic & Pneumatic Power for Production'**, Harry L. Stewart
4. **'Pneumatic Systems',** S. R. Majumdar, Tata McGraw Hill Publish 1995
5. **'Power Hydraulics'** Michael J Pinches & John G Ashby, Prentice Hall.

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each full question shall contain maximum of 3 subdivisions.

COURSE OUTCOME (CO)

After completion of the course, students will be able to:

1. Outline the basics of hydraulics and pneumatics.
2. Identify symbols and notations associated with hydraulics and pneumatics.
3. Solve simple numerical problems on operations.
4. Select basic fluid power maintenance procedures.
5. Ability to design hydraulic and pneumatic circuits
6. Use hydraulics and pneumatics models for development of automatic systems.

MAPPING OF COs WITH POs

COs/POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	3	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2015-16 ACADEMIC YEAR: 2018-19
SEMESTER : SEVENTH

COURSE TITLE : RAPID PROTOTYPING		
Sub Code: ME731	**No of Credits : L-T-P-SS 03:00:00:00 =03**	**No. of lecture hours/week : 03**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 100**
Pre-requisites	**Manufacturing process**	

COURSE OBJECTIVES:

1. Describe the manufacturing techniques of rapid prototyping process.
2. Successfully apply the following techniques in rapid prototyping process.
3. Analyze the different Rapid tooling methods.
4. Evaluate optimization in Rapid Manufacturing process.

#	CONTENTS	hr
UNIT-1	**INTRODUCTION**	**5**
	Need for the compression in product development, history of RP systems, Survey of applications, Growth of RP industry and classification of RP systems, general steps in producing components using RP technology. **STEREO LITHOGRAPHY SYSTEMS:** Principle, Process parameter, Process details, Data preparation, data files and machine details, Application.	
UNIT-2	**RP PROCESSES:**	**6**
	Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications. FUSION DEPOSITION MODELLING: Principle, Process parameter, Path generation, Applications.	
UNIT-3	**SOLID GROUND CURING:**	**6**
	Principle of operation, Machine details, Applications. Laminated Object manufacturing: Principle of operation, LOM materials Process details, application. CONCEPTS MODELERS: Principle, Thermal jet printer, Sander's model market, 3-D printing. GenisysXs printer HP system 5, object Quadra systems, comparisons of different RP technologies.	
UNIT-4	**RAPID TOOLING :**	**11**
	Indirect Rapid tooling, Silicone rubber tooling, Aluminum filled epoxy tooling, Spray metal tooling, Cast Kirksite, 3Q Keltool, etc. Direct Rapid Tooling Direct. AIM. RAPID TOOLING**:** Quick Cast process, Copper polyamide, Rapid Tool, DMLS, Prometal, Sand casting tooling, Laminate tooling soft Tooling vs. Hard tooling.	
UNIT-5	**SOFTWARE FOR RP**	**11**

	STL files, Overview of Solid view, Magics, Imics, Magic communicator, etc. Internet based software, Collaboration too factors influencing accuracy. Data preparation errors, Part building errors, Error in finishing, Influence of build orientation.	

Text books:

1. Stereo Lithography and other RP & M Technologies, Paul F. Jacobs: SME, NY 1996
2. Rapid Manufacturing, Flham D.T &Dinjoy S.S Verlog London 2001

References:

1. Rapid Prototyping, Terry Wohler's Report 2000" Wohler's Association 2000
2. Rapid Prototyping Materials, Gurumurthi, IISc Bangalore.
3. Rapid Automated, Lament wood. Indus press New York

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)

CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each full question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Describe fundamentals of Rapid Prototyping technology
2. Classify RP techniques for preparing prototypes for a given product
3. RP techniques such as SLA, SLS, FDM, SGC, LOM based on their applicability, materials used, and advantages
4. Apply rapid tooling technique for a specified product
5. Create RP models using software tools
6. Analyze advanced RP techniques for their suitability and merits.

ADMISSION YEAR : 2015-16 ACADEMIC YEAR: 2018-19

SEMESTER : SEVENTH

COURSE TITLE : INTERNAL COMBUSTION ENGINES (CORE ELECTIVE)		
Sub Code: ME732	**No of Credits : L-T-P-SS 03:00:00:00 =03**	**No. of lecture hours/week : 03**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 100**
Pre-requisites	**Basic and Applied, Thermodynamics**	

Course objectives:

1. To understand the basic principle of thermodynamic process
2. To understand the basic components and structure of IC engines (both SI and CI engines), process parameters.
3. Understanding the performance of the engine, combustion and exhaust parameters.

Unit no.	CONTENTS	Hrs.
1	**CARBURETION** Introduction, Definition, factors affecting carburetion, air-fuel mixture, mixture requirement, principle of carburetion, simple carburettor, calculation of air-fuel ratio, essential parts of a carburettor, compensating devices, additional systems in modern carburettors, types of carburettors, automobile carburettors, altitude compensation, Numericals.	**07**
2	**INJECTION SYSTEMS** Introduction, Functional requirements, Classification, Fuel feed pump, Injection pump, Injection pump governor, Mechanical and pneumatic governor, Fuel injector, nozzle, Injection in SI engine, Numerical problems, Gasoline injection, Electronic fuel injection system, Multipoint fuel injection system, Functional divisions of MPFI system, Electronic control system, Injection timing, Group gasoline and electronic diesel injection system, Injection control.	**06**
3	**COMBUSTION and COMBUSTION CHAMBERS** Introduction, homogeneous and heterogeneous mixture, combustion and its stages in SI and CI engine, flame front propagation, factors influencing the flame speed, rate of pressure rise, abnormal combustion, factors affecting the delay period, adiabatic flame temperature, phenomenon of knock in SI and CI engine, effect of engine variable in knock, combustion chambers for SI and CI engine, combustion and its stage in CI engine, comparison of knock in SI and CI engine.	**06**
4	**Measurement and Testing of Performance Parameters** Introduction, measurement of friction power, indicated power, brake power, fuel and air consumption, speed, exhaust and coolant temperature, emission, noise and combustion parameters; engine efficiencies, performance characteristics, factors affecting performance, methods of improving engine performance, heat balance, performance maps, analytical method of performance estimation, Numericals.	**10**
5	**NON CONVENTIONAL ENGINES** Introduction, Construction, working principle and design of CRDI engine, dual fuel and multi-fuel engine, free piston engine, Gasoline Direct Injection Engine, HCCI engine, Lean burn engine, Stirling engine, Stratified charge engine, VCR engine and Wankel engine.	**10**

TEXT BOOKS

1.Internal Combustion Engines, V. Ganesan, Tata Mc-Graw Hill Publications,4 Edition, 2012.
2. Internal Combustion Engines, M. L. Mathur and R. P. Sharma, Dhanpat Rai Publications, 2014.

REFERENCE BOOKS

1.Internal Combustion Engine Fundamentals, John B. Heywood, Mc-GrawHill Education India Limited, 2011.
2.Engineering Fundamentals of the Internal Combustion Engines ,WillardW., Pulkrabek. Pearson Education, 2 Edition, 2015.
3. A Text Book of Internal Combustion Engines, R.K. Rajput, Laxmi Publishers, 2007.

QUESTION PAPER PATTERN (SEE)

Q No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
Unit	1	2	3	4		5	

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES:

On completion of the course, student should be able to;
1. Describe the carburetion and combustion processes with examples.
2. Explain the fuel injection systems in IC engines.
3. Select suitable combustion chambers for IC engines.
4. Evaluate the performance parameters of IC engines.
5. Derive the performance characteristics of engines.
6. Summarize the non-conventional engines in the context of modern developments.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	3	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2015-16 ACADEMIC YEAR: 2018-19
SEMESTER : SEVENTH

COURSE TITLE : ENGINEERING ECONOMICS		
Sub Code: ME733	**No of Credits : L-T-P-SS 03:00:00:00 =03**	**No. of lecture hours/week : 03**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 100**
Pre-requisites	**Engineering mathematics**	

COURSE OBJECTIVES:

1. Helping decision making
2. Calculation of interest
3. Arriving at break-even point
4. Feasibility study from economic point of view
5. Preparation of budget
6. Understanding financial statements
7. Arriving at the product cost.

UNIT	CONTENTS	Hrs.
UNIT-1	**INTRODUCTION**	**7**
	Elements of engineering economics, engineering decision- makers, engineering and economics, problem solving and decision making, intuition and analysis, tactics and strategy. Engineering economic decision, maze. Law of demand and supply, law of returns, interest and interest factors: interest rate, simple interest, compound interest, cash - flow diagrams, personal loans and EMI payment, exercises and discussion.	
UNIT-2	**PRESENT-WORTH COMPARISONS:**	**6**
	Conditions for present worth comparisons, basic present worth comparisons, present-worth equivalence, net present-worth, assets with unequal lives, infinite lives, future-worth comparison, pay-back comparison, exercises, discussions and problems.	
UNIT-3	**RATE-OF-RETURN CALCULATIONS AND DEPRECIATION**:	**6**
	Rate of return, minimum acceptable rate of return, IRR, IRR misconceptions, cost of capital concepts. Causes of depreciation, basic methods of computing depreciation charges, tax concepts, and corporate income tax.	
UNIT-4	**INTRODUCTION, SCOPE OF FINANCE, FINANCE FUNCTIONS:**	**10**
	Statements of financial information: introduction, source of financial information, financial statements, balance sheet, profit and loss account, relation between balance sheet and profit and loss account. Simple Numericals. **FINANCIAL RATIO ANALYSIS**: Introduction, nature of ratio analysis, liquidity ratios, leverage ratios, activity ratios, profitability ratios, evaluation of a firm's earning power. Comparative statements analysis. Simple Numericals.	
UNIT-5	**FINANCIAL AND PROFIT PLANNING**:	**10**
	Introduction, financial planning, profit planning, objectives of profit planning, essentials of profit planning, budget administration, type of budgets, preparation of	

	budgets, advantages, problems and dangers of budgeting. Introduction to bench marking of manufacturing operation. **ESTIMATING AND COSTING:** Components of costs such as direct material costs, direct labor costs, fixed over-heads, factory cost, administrative overheads, first cost, marginal cost, selling price, estimation for simple components.	

TEXT BOOKS:

1. Engineering Economy, Riggs J.L., McGraw Hill, 2002
2. Engineering Economy, Thuesen H.G. PHI , 2002

REFERENCE BOOKS:

1. Engineering Economy, Tarachand, 2000.
2. Industrial Engineering and Management, OP Khanna, Dhanpat Rai & Sons. 2000
3. Financial Management, Prasanna Chandra, TMH, 2004
4. Financial Management, IM PANDEY, Vikas Publisahing House, 2002

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)

CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each full question shall contain maximum of 3 subdivisions.
4.

COURSE OUTCOMES: At the end of the course the student will be able to;

1. Take the right financial decision
2. Help in calculating the financial factors
3. Arrive at feasibility study of the project
4. Train to prepare the budget.

ADMISSION YEAR : 2015-16 ACADEMIC YEAR: 2018-19
SEMESTER : SEVENTH

COURSE TITLE : COMPUTER AIDED MODELING AND ANALYSIS LABORATORY		
Sub Code: MEL74	**No of Credits : L-T-P-SS 0:0:2:0 = 1**	**No. of lecture hours/week : 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 50**
Pre-requisites	**Engineering mathematics, MOM, DME**	

COURSE OBJECTIVES:

1. To be able to understand and handle design problems in systematic manner
2. To gain practical experience in 2D drafting and 3D modeling software systems.
3. To be able to apply CAD in real life applications.
4. 4.To be able to understand meaning and Usefulness of FEM
5. To be able to understand Various software used to solve the practical problems

#	Contents	h
UNIT-1	**STUDY OF A FEA PACKAGE AND MODELING STRESS ANALYSIS OF**	**13**
	a. Bars of constant cross section area, tapered cross section area and stepped bar b. Trusses – (Minimum 2 exercises) c. Beams – Simply supported, cantilever, beams with UDL, beams with varying load etc (Minimum 6 exercises) d. Includes Theoretical problems and Introduction to meshing	
UNIT-2	**STRESS ANALYSIS OF**	**13**
	a) Stress analysis of a rectangular plate with a circular hole b) Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions(Minimum 4 exercises) c) Dynamic Analysis 1) Fixed – fixed beam for natural frequency determination 2) Bar subjected to forcing function Fixed – fixed beam subjected to forcing function	

REFERENCE BOOKS:

1. A first course in the Finite element method, Daryl L Logan, Thomason, 3rd Ed.
2. Fundaments of FEM, Hutton – McGraw Hill, 2004
3. Finite Element Analysis, George R. Buchanan, Schaum Series

QUESTION PAPER PATTERN (SEE)

UNIT	1	2
Q. No.	**Q1**	**Q2**

SCHEME OF EXAMINATION (SEE)

Sl. No.	Particulars	Max. Marks	Break Up of Max. Marks		
			Write Up	Conduction of experiment / Modelling Analysis	Expected Out Putt-Results (Different displacement, BM, Stress, Strain results. Etc. and Plotting deformation diagram, SFD,BMD, Graph if it's required)
1	**Unit-1: Minor Experiment** (Any ONE from the list of experiments and it is purely individual Experiment) Q1	**20**	05	05	10
2	**Unit-2: Major Experiment** (Any ONE **Experiment** from the list of experiments and it is a Group Experiment) Q2	**20**	05	5	10
3	Viva Voce	**10**	--	--	--
	TOTAL MARKS	**50**			

- Two Full Questions to be set.
- Students shall be to be answered two full Questions.
- Each question (Experiments contains different Marks and it is clearly mentioned in the above table)
- Changing of Experiments is not allowed from any unite if changing of experiments allowed 50% marks will be deducted.
- Viva Voce is compulsory

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Explore the Techniques of 2D and 3D Computer Aided Design (CAD)
2. Elaborate the applications and limitations of different Auto CAD, Micro Station, CATIA, Pro- E,I-DEAS, Existing FEA software's (ANSYS, NISA, CAEFEM, Abaqus, Msc-Nastran, Optistruct / Radioss, Comsol-Multiphysics system types and their applications.
3. Students will be able to solve a stress analysis problem theoretically, compare the same with results of the software and able to understand the importance of theoretical calculations.
4. Students will be able to assign the different element types, properties and also material models to the structure being analyzed and also students will be able to carry out static, dynamic thermal analysis using ansys to get required Output results.

MAPPING OF COs WITH Pos

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l

1	3	3	3	2	2	3	3	2	3	3	1	2
2	2	3	3	2	2	1	3	2	3	3	3	2
3	3	3	3	2	3	2	3	1	3	2	3	2
4	3	3	2	2	3	2	3	1	2	2	3	3

- **High-3**
- **Medium-2**
- **Low-1**

ADMISSION YEAR : 2015-16 **ACADEMIC YEAR: 2018-19**
SEMESTER : SEVENTH

COURSE TITLE : PROJECT WORK PHASE-I		
Sub Code: MEP75	**No of Credits : L-T-P-SS 0:0:2:0 = 0**	**No. of lecture hours/week : 00**
Exam Duration : NA		**Exam Marks : 50**

Course objectives:

1. To provide an amicable atmosphere for students to plan
2. To test their learned theory knowledge in an actual working situation
3. To discover the value of work and relish rewards of accomplishment
4. To ensure a professional preparation to the liberal educational goals.

Unit No.	SYLLABUS	Hrs
1	**Definition of the problem**	
2	**Exhaustive literature survey**	
3	**Methodology**	

The Project proposal shall be submitted within 3 weeks from the start of the semester in the prescribed standard format (04 copies) to the HOD, after the certification of the concerned guide and HOD.

Minimum No. of students per batch: 02 Maximum No. of students per batch: 04

CIE Evaluation: Two seminars shall be conducted at the end of 6 and 10 week of the semester.

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Literature review on par with international journal standards
2. Literature gap determination and definition of the problem
3. Scientific Design / Numerical Analysis / Analytical model and interpret them
4. Apply tools / techniques for problem solving and prepare project work

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2015-16 ACADEMIC YEAR: 2018-19
SEMESTER : EIGTH

COURSE TITLE : COMPUTER INTEGRATED MANUFACTURING (CIM)		
Sub Code: ME811	**No of Credits : L-T-P-SS 03:00:00:00 =03**	**No. of lecture hours/week : 03**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 100**
Pre-requisites		

Course Description

This course is designed to give you a thorough understanding of the technology used in manufacturing systems. You will also be introduced to the concepts of computer integrated manufacturing and relevant standards, feature technology, product life cycle management, computer aided manufacturing, and computer numerical control.

Objectives This course contributes to the following program learning outcomes of the Master of Engineering:

1. Needs, Context and Systems: Exposit legal, social, economic, ethical and environmental interests, values, requirements and expectations of key stakeholders

2. Analysis: Apply underpinning natural, physical and engineering sciences, mathematics, statistics, computer and information sciences.

3. Professional Practice: Understand the scope, principles, norms, accountabilities and bounds of contemporary engineering practice in the Demonstrate effective team membership and team leadership. Display a personal sense of responsibility for your work

4. Research: Demonstrate professional use and management of information.

UNIT	CONTENT	Hrs
UNIT 1	**COMPUTER INTEGRATED MANUFACTURING SYSTEMS:** Introduction, Automation definition, Types of automation, CIM, processing in manufacturing, Production concepts, Mathematical Models-Manufacturing lead time, production rate, components of operation time, capacity, Utilization and availability, Work-in-process, WIP ratio, TIP ratio, Problems using mathematical model equations. Automation Strategies.	**07**
UNIT 2	**HIGH VOLUME PRODUCTION SYSTEM:** Introduction Automated flow line-symbols, objectives, Work part transport-continuous, Intermittent, synchronous, Pallet fixtures, Transfer Mechanism-Linear-Walking beam, roller chain drive, Rotary-rack and pinion, Rachet & Pawl, Geneva wheel, Buffer storage, control functions-sequence, safety, Quality, Automation for Machining operation. **ANALYSIS OF AUTOMATED FLOW LINE & LINE BALANCING:** General terminology and analyisis, Analysis of Transfer Line without storage upper bound approach, lower bound approach and problems, Analysis of	**06**

	Transfer lines with storage buffer, Effect of storage, buffer capacity with simple problem, Partial automation-with numerical problems, flow lines with more than two stages, Manual Assembly lines, line balancing problem.	
UNIT 3	**ANALYSIS OF AUTOMATED FLOW LINE & LINE BALANCING:** General terminology and analyisis, Analysis of Tranfer Line without storage upper bound approach, lower bound approach and problems, Analysis of Transfer lines with storage buffer, Effect of storage, buffer capacity with Simple problem, Partial automation-with numerical problems. **MINIMUM RATIONAL WORK ELEMENT:** Work station process time, Cycle time, precedence constraints. Precedence diagram, Balance delay methods of line balancing-largest Candidate rule, Kilbridge and Westers method, Ranked positional weight method, Numerical problems covering above methods and computerized line balancing.	**10**
UNIT 4	**AUTOMATED ASSEMBLY SYSTEMS**: Design for automated assembly systems, types of automated assembly system, Parts feeding devices-elements of parts delivery system-hopper, part feeder, Selectors, feedback, escapement and placement analysis of Multi station Assembly Machine analysis of single station assembly. **Automated Guided Vehicle System**: Introduction, Vehicle guidance and routing, System management, Quantitative analysis of AGV's with numerical problems and application.	**10**
UNIT 5	**COMPUTERIZED MANUFACTURING PLANNING SYSTEM:** Introduction, Computer Aided Process Planning, Retrieval types of process planning, Generative type of process planning, Material requirement Planning, Fundamental concepts of MRP inputs to MRP, Capacity planning. Shop Floor Control: Factory, Data Collection System, Automatic identification system. Computer Aided Quality Control: Contact inspection methods, Non-Contact inspection methods, Co-ordinate measuring machine.	**06**

TEXT BOOKS:

1. **Automation, Production system & Computer Integrated manufacturing,** M. P. Groover" Person India, 2007 2nd edition.

2. **Principles of Computer Integrated Manufacturing,** S. Kant Vajpayee, Prentice Hall India.

REFERENCE BOOKS:

1. **Computer Integrated Manufacturing,** J. A. Rehg& Henry. W.Kraebber.

2. **CAD/CAM by Zeid,** Tata McGraw Hill.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven Full Questions to be set.

2. Five full Questions to be answered.
3. Unit-1, Unit-2 and Unit-5 are compulsory, with one question from eachUnit.
4. Unit-3 and Unit-4: Two questions to be set with choice.

Course Outcomes (COs)

On completion of this course you should be able to:

1. Identify the main elements in computer integrated manufacturing systems;
2. Apply knowledge of computer aided process planning, feature and group technology, and data exchange in manufacturing processes.
3. Apply the concepts/components of computer integrated manufacturing and integrate them in a coordinated fashion;
4. Process product models with CAM tools and CNC machines.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2015-16 ACADEMIC YEAR: 2018-19
SEMESTER : EIGTH

COURSE TITLE : COMPUTATIONAL FLUID DYNAMICS		
Sub Code: ME812	**No of Credits : L-T-P-SS 03:00:00:00 =03**	**No. of lecture hours/week : 03**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 100**
Pre-requisites	**Fluid dynamics, Mathematics**	

COURSE OBJECTIVES:

1. To understand the fundamentals of CFD and fluid flow equations in conservation forms.
2. To explain finite difference method and approximations used in this method.
3. To understand the finite volume and finite element methods of discretizing the partial differential equations.
4. To know the various methods of grid generation and solving the differential equations.
5. To understand the concept of viscous compressible flow and related equations.

#	CONTENTS	hr
UNIT-1	**INTRODUCTORY CONCEPTS**	**07**
	Introduction: Conservation equations; Mass, momentum and energy equations; Conservative forms of the equations and general description; Classification and Overview of Numerical Methods: Classification into various types of equations – parabolic, elliptic and hyperbolic; Boundary and initial conditions; Overview of numerical methods.	
UNIT-2	**FINITE DIFFERENCE METHOD**	**06**
	Introduction, finite difference approximations, Taylor series expansion, polynomial fitting, approximation of boundary conditions, applications to conduction and advection-diffusion problems.	
UNIT-3	**FINITE VOLUME AND FINITE ELEMENT METHODS**	**06**
	Finite Volume Method: Basic methodology, finite volume discretization, approximation ofsurface and volume integrals, interpolation methods – central, upwind and hybrid formulations and comparison for convection-diffusion problem; Finite Element Method: Introduction to Rayleigh-Ritz, Galerkin and least square methods, interpolation functions, one and two dimensional elements, applications.	
UNIT-4	**GRID GENERATION AND SOLUTION METHODS**	**10**
	Introduction; Classification; Principles of structured mesh generation; Structured grid generation techniques; Unstructured mesh generation; Adaptive mesh generation; Solution of finite difference equations, iterative methods, matrix inversion methods, ADI method, operator splitting, fast Fourier transform, applications; Time integration Methods: Single and multilevel methods; predictor-corrector methods; stability analysis; Applications to transient conduction and advection-diffusion problems.	
UNIT-5	**VISCOUS COMPRESSIBLE FLOW**	**10**

	Navier-Stokes Equations: Explicit and implicit methods; SIMPLE type methods; fractional step methods; Phase Change Problems: Different approaches for moving boundary, variable time step method, enthalpy method; Turbulence modeling: Reynolds averaged Navier-Stokes equations, RANS modeling, DNS and LES.	

TEXT BOOKS:

1. **Computational Fluid Dynamics: The Basics with Applications,** John D. Anderson, Jr., McGraw-Hill International Editions, 1995.
2. **Computational Fluid Flow and Heat Transfer,** K. Muralidhar and T.Sundararajan (Editors), 2nd Edition, Narosa Publishing House, 2003.
3. **Computational Fluid Dynamics: An Introduction**, John F. Wendt (Editor), Springer (India) Pvt. Ltd., 3rd Edition, 2007.

REFERENCE BOOKS:

1. **Computational Fluid Methods for Fluid Dynamics**, J.H. Ferziger and M. Peric, Springer (India) Pvt. Ltd., 3rd Edition, 2002.
2. **Introduction to Computational Fluid Dynamics**, PradipNiyogi, S.K. Chakrabartty, M.K. Laha, Pearson Education, 2011.
3. **Numerical Heat Transfer and Fluid Flow**, Suhas V. Patankar, Hemisphere Publishing Corporation, 1980.

e-LEARNING RESOURCES

1. **Videos, Lecture notes:** http://www.nptel.ac.in
2.

QUESTION PAPER PATTERN (SEE):

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each question shall contain maximum of 3 subdivisions.

COURSE OUTCOME (CO)

After completion of the course, students will be able to:

1: Describe the different flow models, physical boundary conditions and governing equations suited for CFD.
2: Illustrate the applications of finite differences in partial differential equations with examples.
3: Sketch and explain the structured, unstructured and adaptive meshes used in the CFD analysis.
4: Compare and differentiate the various CFD techniques used in the finite volume method.
5: Derive expressions of governing equations for viscous and inviscid flows.

6: Relate the various modeling, mesh generation and CFD techniques used in viscous and inviscid flows.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	2	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2015-16 ACADEMIC YEAR: 2018-19
SEMESTER : EIGTH

COURSE TITLE : SMART MATERIALS		
Sub Code: ME813	**No of Credits : L-T-P-SS 03:00:00:00 =03**	**No. of lecture hours/week : 03**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 100**
Pre-requisites	**Material science, Composite materials**	

COURSE OBJECTIVES:

1.The aim of this course is to integrate research results with curriculum development for the benefit of the students in physics, materials science and engineering civil and structural engineering, mechanical and aerospace engineering, industrial and systems engineering, as well as electrical and electronic engineering.

2.The fundamentals of smart materials, device and electronics, in particular those related to the development of smart structures and products.

3. The skills, knowledge and motivation in the design, analysis and manufacturing of smart structures and products.

#	CONTENTS	Hrs
UNIT-1	**INTRODUCTION TO SMART MATERIALS** Characteristics of composites and ceramic materials, Smart materials and their types, dynamics and controls, concepts, Electro-magnetic materials and shape memory alloys-processing and characteristics.	**06**
UNIT-2	**SMART STRUCTURES** Types of smart Structures, potential feasibility of smart structures, key elements of smart structures, applications of smart structures. Piezoelectric materials, properties, piezoelectric constitutive relations, poling and coersive field, field strain relation. Hysteresis, creep and strain rate effects, inchworm linear motor.	**06**
UNIT-3	**SENSING AND ACTUATION** Principles of electromagnetic, acoustics, chemical and mechanical sensing and actuation, Types of sensors and their applications, signal processing, principals and characterization of sensors.	**06**
UNIT-4	**SHAPE MEMORY ALLOY:** Experimental Phenomenology, Shape Memory Effect, phase transformation, super elasticity, Tanaka's constitutive model, SME testing of SMA wires, vibration control through SMA, Testing of super elasticity, Applications Of SMA. **ER AND MR FLUIDS:** Mechanisms and properties, fluid composition and behavior, The Bingham plastic and	**11**

	related models, pre-yield response. Post-yield flow applications in clutches, dampers and others.	
UNIT-5	**VIBRATION ABSORBERS: S**eries and parallel damped vibrations (overview), active vibration absorbers, fiber optics, physical phenomena, characteristics, sensors, fiber optics in crack detection, applications, biomimetics. **MEMS:** Mechanical properties of MEMS materials, scaling of mechanical systems, fundamentals of theory, the intrinsic characteristics of MEMS, miniaturization, microelectronics integration.	**10**

TEXT BOOKS:

1. **‘Analysis and Design’,** A. V. Srinivasan, ‘Smart Structures –Cambridge University Press, New York, 2001, (ISBN : 0521650267)
2. **‘Smart Materials and Structures’,** M V Gandhi and B S Thompson Chapmen & Hall, London, 1992 (ISBN : 0412370107)

REFERENCE BOOKS:

1. **‘Smart Materials and Structures’,** Banks HT, RC Smith, Y Wang, Massow S A, Paris 1996
2. **G P Gibss’AdaptiveStructres’,** Clark R L, W R Saunolers, Jhon Wiles and Sons, New York, 1998
3. **An introduction for scientists and Engineers’,**EsicUdd, Optic Sensors :Jhon Wiley & Sons, New York, 1991 (ISBN : 0471830070).

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)

CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each full question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES:

On completion of this COURSE, students should be able to:

(1) Understand the physical principles underlying the behavior of smart materials;

2) Understand the engineering principles in smart sensor, actuator and technologies

(3) Use principles of measurement, signal processing, drive and control techniques necessary to developing smart structures and products; and

(4) Appreciate and suggest improvement on the design, analysis, manufacturing and application issues involved in integrating smart materials and devices with signal processing and control capabilities to engineering smart structures and products.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	3	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2016-17 ACADEMIC YEAR: 2018-19
SEMESTER : EIGTH

COURSE TITLE : CONTROL ENGINEERING LABORATORY		
Sub Code: MEL82	**No of Credits : L-T-P-SS 0:0:2:0 = 1**	**No. of lecture hours/week : 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 50**
Pre-requisites	**Control engineering**	

COURSE OBJECTIVES:

1. To understand the basics of control system.
2. To control the heat flow rate and temperature in a tank.
3. To determine effectiveness of PID controller in heating tanks
4. To analyse the control action on the liquid levels in tanks.
5. To control the speed of DC motor.

#	CONTENTS	Hrs
UNIT-1	Basics and heated tank	6
	1. No control heated tank 2. Bump less transfer heated tank 3. General transfer function 4. Anti-windup heated tank 5. PID standard temperature control of heated tank 6. Cascade temperature control of heated tank.	
UNIT-2	Liquid level control	6
	1. Manual level control 2. PID standard level control in chip tank 3. PID discrete General transfer function 4. Feed forward liquid level control in single tank. 5. Feed forward liquid level control in double tank.	
UNIT-3	Speed control of DC motor	8
	1. Step test 2. Set point weighing 3. Position and step test 4. Speed integral control 5. PI implementation. 6. PID position implementation.	

UNIT-4	**Magnetic levitation**	6
	1. On-off control 2. P- control 3. Transient response 4. PD control for desired pole placement **5.** PD control for desired transient response	

SCHEME OF EXAMINATION:

One Question from Unit – 1 or 2 – 15 Marks (05 Write up +10)
One Question from Unit – 3 or 4 – 25 Marks (05 Write up +20)
Viva-Voce - 10 Marks
Total - 50 Marks

COURSE OUTCOMES:

1. Evaluate thermal control action and effectiveness of PID control.
2. Plot the characteristic graphs to analyse of liquid level control.
3. Develop motors speed controls as required in industries.
4. Evaluate and optimise the magnetic levitation system.

ADMISSION YEAR : 2016-17 ACADEMIC YEAR: 2018-19
SEMESTER : EIGTH

COURSE TITLE : SUBJECT SEMINAR		
Sub Code: MES83	**No of Credits : L-T-P-SS 0:0:4:0 = 2**	**No. of lecture hours/week : 04**
Exam Duration : 3 hours		**Exam Marks : 50**

COURSE OBJECTIVES:
1. To equip students for making a technical presentation based on a thorough re-search review on any contemporary area of Engineering and Management fields
2. Offering the student an opportunity to interact with faculty and peer group and to build the ability to making independent presentation.

#	SYLLABUS	Hr
UNIT 1	Seminar shall be presented during 8 / 9 week of the semester in the department before the Departmental Evaluation Committee constituted by HOD.	**24**
UNIT 2	The seminar marks are to be awarded by the committee.	**14**
UNIT 3	Students shall submit the seminar report in the prescribed standard format.	**14**

COURSE OUTCOMES: On completion of the course, student should be able to;
1. Conduct literature survey on a current topic based on peer reviewed literature
2. Identify research gap in the literature
3. Develop methodologies to resolve the identified problem(s)
4. Develop presentation slides / report arranging the material coherently
5. Present and discuss the topic with clarity and confidence and submit the report
6. Summarize the presentation and identify scope for further work

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	2	1	3	1	1	1	1	2	1	1

- **High-3**
- **Medium-2**
- **Low-1**

ADMISSION YEAR : 2016-17 ACADEMIC YEAR: 2018-19
SEMESTER : EIGTH

COURSE TITLE : PROJECT WORK PHASE – II		
Sub Code: MEP84	**No of Credits : L-T-P-SS 02:0:8:4= 12**	**No. of lecture hours/week : 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**

COURSE OBJECTIVES:

1. To provide an opportunity and atmosphere in which students may test theory learned in the classroom in an actual working situation and discover the value of work and the rewards of accomplishment
2. To insure a natural transition to the higher level of professional preparation as a complement to the liberal education goals of the Institution.

#	SYLLABUS	Hrs
UNIT 1	Analysis based on type of problem.	**30**
UNIT 2	Conclusions, scope for further work.	**90**
UNIT 3	References.	**10**

OUTCOMES: On completion of the course, student should be able to;

1. Perform literature review on par with international journal standards
2. Identify literature gap and define the problem
3. Design Experiments scientifically / Perform Numerical Analysis / Develop Analytical models
4. Interpret the Experimental / Numerical / Analytical Results
5. Apply advanced tools / techniques for solving the problem
6. Prepare quality document of project work

CIE EVALUATION: Two presentations shall be conducted at the end of 6 and 10 week of the semester. The Project Report shall be submitted in the prescribed standard format (04 copies) to the HOD, after the certification of the concerned guide and HOD.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	2	1	3	1	1	1	1	2	1	1

- **High-3**
- **Medium-2**
- **Low-1**

ADMISSION YEAR : 2016-17 ACADEMIC YEAR: 2018-19
SEMESTER : FIFTH

COURSE TITLE : DESIGN OF MACHINE ELEMENTS – I		
Sub Code: ME51	**No of Credits : L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week : 04**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**MOM, Material science and metallurgy**	

COURSE OBJECTIVES:

This course "Design of Machine Elements -1" is designed with the following objectives in mind:

Objectives

1. To study basic principles of machine design
2. To acquaint with the concepts of strength design related to various components.
3. To familiarize with use of design data books & various codes of practice.
4. To make conversant with preparation of working drawings based on designs and enable the students to have high ethical standards in terms of team work to be a good design engineer

#	CONTENTS	Hrs
UNIT-1	**INTRODUCTION:** Introduction to machine design, Classification, Phase/steps in Machine design process. Design Considerations, Design Method, mechanical Properties and IS coding of various materials, Selection of material from properties and economic aspects. Manufacturing Considerations in Design: Standardization, Interchangeability, limits, fits tolerances and surface roughness, BIS codes, Design consideration for cast, forged and machined parts. Codes and standards, Stress-strain diagrams, Stress analysis, Definitions: normal, shear, biaxial and tri axial stresses, Stress tensor, Principal Stresses and their directions, Shear stress and their directions.	08
UNIT-2	**DESIGN FOR STATIC STRENGTH:** Static loads and factor of safety, Theories of failure: Maximum normal stress theory, Maximum shear stress theory, Maximum strain theory, Strain energy theory, Distortion energy theory. Failure of brittle and ductile materials, **STRESS CONCENTRATION:** Definition, Reason for occurrence, Methods to reduce, Stress concentration factor. Stress concentration charts, stress concentration and static loads and compound stress concentration factors Design of stress concentrated members subjected to various loads and Numerical problems.	09
UNIT-3	**DESIGN FOR FATIGUE STRENGTH**: Introduction- S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit, fatigue failure prevention.Modifying factors: size effect, surface effect, Stress concentration effects, Fluctuating stresses, Goodman and Soderberg relation, stresses due to combined loading, cumulative fatigue damage. Problems on design of members for finite & infinite life in members subjected to individual & combined loading. Cumulative damage in fatigue. **IMPACT STRENGTH:** Introduction, Impact stresses due to axial, bending and torsional loads, effect of inertia. Numerical problems.	10

UNIT-4	**DESIGN OF SHAFTS**: Types, Design of solid & hollow shaft on strength and rigidity basis with steady loading subjected to pure torsion with steady loading, Design of shafts carrying pulleys & gears (Combined loading). ASME codes for power transmission shafting, shafts under fluctuating loads and combined loads and Numerical problems. **KEYS:** Types of Keys and their selection based on shafting condition, key ways, splines. **SHAFT COUPLINGS**: Introduction, classification, advantages, and applications of Couplings: design of Rigid and flexible couplings, Flange coupling, Bush and Pin type coupling and Oldham's coupling and Numerical problems.	13
UNIT-5	**DESIGN OF TEMPORARY AND PERMANENT JOINTS** **RIVETED JOINTS**: Types, rivet materials, Modes of failures of riveted joints, Strength Equations – efficiency of riveted joints, Joint Efficiency, Boiler Joints, Lozenge Joints, Riveted Brackets, Eccentrically riveted joints and Numerical problems . **WELDED JOINTS:** Types, Strength of butt and fillet welds, eccentrically loaded welded joints and Numerical problems. **BOLTED JOINTS:** Design of bolts with pre-stresses – Design of joints under eccentric loading.	12

TEXT BOOKS:

1. **Mechanical Engineering Design,** Joseph E Shigley and Charles R. Mischke. McGraw Hill International edition, 6th Edition 2009.
2. **Design of Machine Elements,** V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2007.

DESIGN DATA HANDBOOK:

1. **Design Data Hand Book,** K. Lingaiah, McGraw Hill, 2nd Ed.
2. **Data Hand Book,** K. Mahadevan and Balaveera Reddy, CBS Publication
3. **Design Data Hand Book,** H.G. Patil, Shri Shashi Prakashan, Belgaum.

REFERENCE BOOKS:

1. **Machine Design,** Robert L. Norton, Pearson Education Asia, 2001.
2. **Design of Machine Elements,** M. F. Spotts, T. E. Shoup, L. E. Hornberger, S. R. Jayram and C. V. Venkatesh, Pearson Education, 2006.
3. **Machine Design,** Hall, Holowenko, Laughlin (Schaum's Outlines series) Adapted by S.K. Somani, Tata McGraw Hill Publishing Company Ltd., New Delhi, Special Indian Edition, 2008.
4. **Fundamentals of Machine Component Design,** Robert C. Juvinall and Kurt M Marshek, Wiley India Pvt. Ltd., New Delhi, 3rd Edition, 2007.
5. **Fundamentals of Machine Elements** - Hawrock, Jacobson Mcgraw Hill
6. **Machine Design** - Patel, Pandya, Sikh, Vol. - I & II, C.
7. **Fundamentals of Machine Elements** B.J. Hamrock, and S.R. Schmid Tata McGraw Hill, New Delhi, 2005.
8. **The Mechanical Design Process**. D.G. Ullman, Tata McGraw Hill, New Delhi, 2008.

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (Firs100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

(Irrespective of portions covered due to whatever might be the reason)

SCHEME OF EXAMINATION (Question Paper Pattern) (SEE)

1. Seven Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1, Q2 and Q3 from Unit-1, Unit-2 and Unit-3 are compulsory, with one question from each Unit.
4. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5, With Two questions from each Unit.
5. Each question shall contain maximum of 2 subdivisions.
6. Each main question carries equal Marks.

<u>COURSE OUTCOMES:</u> Learners will able to

1. Demonstrate the fundamentals of stress analysis, theories of failure and material science in the design of machine components.
2. Apply basic principles of machine design and to make proper assumptions with respect to material, factor of safety, static and dynamic loads for various machine components.
3. Design machine elements on the basis of strength concept and use design data books and various standard codes of practices.
4. Acquire skill in preparing production drawings pertaining to various designs in real life usage to meet / satisfies the industrial needs and also enable the students to have high ethical standards in terms of team work to be a good design engineer.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	3	2	2	3	2	3	1	3	3
CO2	2	3	3	2	3	3	3	1	2	3	3	2
CO3	3	3	2	3	3	3	1	3	3	2	3	2
CO4	3	3	2	3	3	2	3	2	1	2	3	3

- High-3
- Medium-2
- Low-1

ADMISSION YEAR : 2016-17 **ACADEMIC YEAR: 2018-19**
SEMESTER : FIFTH

COURSE TITLE : DYNAMICS OF MACHINES		
Sub Code: ME52	**No of Credits : L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week : 04**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**KOM**	

COURSE OBJECTIVES:

1. Draw and analyze free body diagram for multiple forces applied on static members of four bar chain and slider mechanism.
2. Design the size of the flywheel for the excess energy storage and retrieval.
3. Define the terms slip and creep in belt drives.
4. Determine the value of balancing mass for the system.
5. Define sensitivity, isochronous, hunting, controlling force with respect to governors.
6. Analyses the effect of gyro on automobile, ship, Aeroplanes.

#	CONTENTS	Hrs
UNIT-1	**STATIC FORCE ANALYSIS:** Introduction, Static equilibrium, Equilibrium of two and three force members. Members with two forces and torque, Free body diagrams, Static force analysis of simple mechanisms. Principle of virtual work, Numericals.	**08**
UNIT-2	**TURNING MOMENT DIAGRAMS:** Simple related definitions, Turning Moment Diagrams and Flywheels, Fluctuation of Energy, Determination of size of a Flywheel, Numerical.	**08**
UNIT-3	**FRICTION AND BELT DRIVES:** Definitions: Types of friction: laws of friction, Flat belt drives, ratio of belt tensions, centrifugal tension, power transmitted Belt thickness and width calculations, Numericals.	**08**
UNIT-4	**BALANCING OF ROTATING MASSES:** Static and dynamic balancing. Balancing of single rotating mass in same plane and in different planes. Balancing of several rotating masses in same plane and in different planes, Numericals. **BALANCING OF RECIPROCATING MASSES:** Inertia effect of crank and connecting rod, single cylinder engine, balancing in multi cylinder-inline engine (primary & secondary forces), V-type engine; Radial engine – Direct and reverse crank method, Numericals.	**14**
UNIT-5	**GOVERNORS:** Types of governors; force analysis of Porter and Hartnell governors. Controlling force, stability, sensitiveness, isochronism, effort and power, Numericals. **GYROSCOPES:** Vectorial representation of angular motion, gyroscopic couple. Effect of gyroscopic couple on the movement of plane disc, naval ship, aero plane, stability of two wheeler and four wheeler taking a turn, Numericals.	**14**

TEXT BOOKS:

1. **Theory of Machines**, Rattan S.S. Tata McGraw Hill Publishing Company Ltd., New Delhi, 3^{rd} Edition, 2009.
2. **Theory of Machines**, Sadhu Singh, Pearson Education. 2^{nd} edition. 2007.

REFERENCE BOOKS:

1. **Theory of Machines & Mechanisms,** J.J. Uicker, G.R. Pennock, J.E. Shigley. Oxford 3^{rd} edition. 2009
2. **Mechanism and Machine Theory**, A.G. Ambekar PHI, 2007.

REMINDER:

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)
(Irrespective of portions covered due to whatever might be the reason)

QUESTION PAPER PATTERN (SEE)

<table>
<tr><td>Q. No.</td><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td><td>Q5</td><td>Q6</td><td>Q7</td></tr>
<tr><td>UNIT</td><td>1</td><td>2</td><td>3</td><td colspan="2">4</td><td colspan="2">5</td></tr>
</table>

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each full question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES:

1. Understand and analyze static equilibrium of simple mechanisms subjected to force and design a flywheel.
2. Understand the operation of bearings and belt drives and design them for power transmission.
3. Understand the concept of static and dynamic balancing and analyze rotating and reciprocating masses in engine for balancing.
4. Understand the concept of gyroscopic action and analyze the stability of ships, planes, 2 wheeler and 4 wheeler automobiles.

ADMISSION YEAR : 2016-17 **ACADEMIC YEAR: 2018-19**
SEMESTER : FIFTH

COURSE TITLE : HEAT TRANSFER		
Sub Code: ME53	**No of Credits : L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week : 04**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Basic thermodynamics, Fluid mechanics**	

COURSE OBJECTIVES:

1. To outline the basic concepts of conduction, convection and radiation heat transfer. This course helps students to derive generalized expression for heat conduction equation.
2. To discuss and illustrate the application of various boundary conditions giving heat transfer examples.
3. To understand the unsteady heat conduction and convection heat transfer and apply the knowledge to solve real time problems.
4. To demonstrate the use of graphical charts for solving analytical problems.
5. To design heat exchangers based on the input variables such as inlet temperature of hot and cold fluids.
6. To evaluate various heat transfer parameters and predict the rate of heat transfer and heat transfer coefficients.

#	Contents	h
UNIT-1	**BASIC CONCEPTS AND CONDUCTION HEAT TRANSFER**	**10**
	Introduction - Modes of heat transfer, Basic laws, Combined heat transfer mechanism, Resistance concept, Boundary conditions of 1st, 2nd and 3rd kind; Thermal contact resistance; Overall heat transfer coefficient; Illustrations of applying the boundary conditions to heat transfer problems; Derivation of general equation of heat conduction in Cartesian coordinates; Special cases; Discussion on 3-D conduction in cylindrical and spherical coordinate systems (No derivation);Steady state heat conduction in simple and composite slabs, cylinders and spheres (uniform thermal conductivity and without heat generation); Introduction to extended surfaces; Derivation of heat transfer and temperature distribution in fins (uniform cross-section without heat generation); Long fin, short fin with insulated tip and without insulated tip and fin connected between two heat sources; Fin efficiency and effectiveness; Related numerical problems.	
UNIT-2	**ONE-DIMENSIONAL UNSTEADY CONDUCTION HEAT TRANSFER**	**10**
	Introduction; Conduction in solids with negligible internal temperature gradient (Lumped system analysis), Use of Transient temperature charts (Heisler's charts) for transient conduction in slab, long cylinder and sphere; use of transient temperature charts for transient conduction in semi-infinite solids. Related numerical problems.	
UNIT-3	**CONVECTION HEAT TRANSFER**	**08**
	Introduction – Boundary layer concept in external and internal flow; Forced Convection - Dimensional analysis for forced convection; Physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers; Use of correlations for flow over simple geometries (flat plate, cylinder and sphere); Use of correlations for flow inside a duct; Related numerical problems; Free or natural convection - Dimensional analysis for free convection; Physical significance of Grashof number; Use of correlations of free convection over flat plates (vertical, horizontal and inclined), cylinders (vertical and horizontal) and spheres; Related	

	numerical problems.	
UNIT-4	**HEAT EXCHANGERS**	**12**
	Introduction; Classification of heat exchangers; Compact, Shell-and-tube and Plate heat exchangers; Overall heat transfer coefficient and fouling factor; Parallel and counter flow heat exchangers; Use of LMTD; Cross flow heat exchangers; Comparison of parallel and counter flow heat exchangers; Heat transfer with phase change; Multi pass heat exchangers; Effectiveness-NTU method; Limiting cases; Heat transfer enhancement in fins; Related numerical problems; Heat pipes – Introduction; Working principle; components; Applications; Limitations	
UNIT-5	**RADIATION HEAT TRANSFER**	**12**
	Introduction; Black bodies separted by a non-absorbing medium; Shape factor; Electrical analogy; Two black surfaces connected by non-conducting and re-radiating walls; Evaluation of shape factor; Radiation heat transfer between gray bodies; Radiosity and Irradiation; Radiation network for gray surfaces exchanging energy; Hottel's crossed string method; Radiation shields; Radiation from cavities; Radiation from Gases and vapours; Radiation combined with converction; Green house effect; Solar radiation; Related numerical problems.	

TEXT BOOKS

1. **Heat and Mass Transfer,** P.K. Nag, 3rd Edition, Tata McGraw-Hill Publications, 2011.
2. **A Course in Heat and Mass Transfer,** Domkundwar, Arora, Domkundwar, DhanpatRai Publications, 2005.

REFERENCE BOOKS

1. **Heat and Mass Transfer: Fundamentals and Applications**, Cengel,Y.A., and Ghajar, A.J., 5th Edition, McGraw-Hill Publications (SIE), 2015.
2. **Principles of Heat and Mass Transfer**, Frank P. Incropera, David P. Dewitt, Theodore L. Bergman, and Adrienne S. Lavine, 7th Edition, Wiley Student Edition, 2013.

e-LEARNING RESOURCES

1. **A Heat Transfer Text Book**, John H Leinard IV and John H Leinard V, 3rd Edition, Phlogiston Press, Cambridge, Massachusetts, USA, 2008.
2. **Heat and Mass Transfer: Mechanical Engineering Handbook**, Kreith, F., Boehm, R.F., et. al., Frank Kreith (Ed), Boca Raton: CRC Press LLC, 1999.
3. **Fundamentals of Heat and Mass Transfer**, Frank P. Incropera, David P. Dewitt, et. al. Frank P. Incropera (Ed), 6th Edition, John Wiley and Sons, 2007.
4. **e-Journal: Frontiers in Heat and Mass Transfer**, http://www.ThermalFluidsCentral.org
5. **Videos, Student slides, Handouts, Lecture notes:** http://www.nptel.ac.in

DATA HAND BOOK AND CHARTS

1. **Heat and Mass Transfer Data Hand Book,** C.P. Kothandaraman, S. Subramanyan, New Age International Publishers, 8th Edition, 2014.
2. **Steam Tables with Mollier Diagram: SI Units**, Mahesh M.Rathore, Dhanpat Rai Publishing Company, 2014.

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

4. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
5. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
6. Each full question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES: On completion of the course, student should be able to;

After completion of the course, students will be able to:

1: Identify the different modes of heat transfer and state the laws related to each of them.

2: Explain the various modes of heat transfer and heat transfer devices with examples and illustrations.

3: Solve numerical problems related to different modes of heat transfer and heat transfer devices.

4: Compare and analyse different modes of heat transfer.

5: Derive expressions for determining the heat transfer rate during steady and unsteady state conduction, convection and radiation modes.

6: Calculate the rate of heat transfer in different modes of heat transfer and compute the performance of various heat transfer systems.

MAPPING OF COs WITH POs

COs/POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2016-17 ACADEMIC YEAR: 2018-19
SEMESTER : FIFTH

COURSE TITLE : COMPUTER AIDED DESIGN AND MANUFACTURING		
Sub Code: ME54	**No of Credits : L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week : 04**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Manufacturing process**	

COURSE OBJECTIVES:
1. To teach the role of CAD/CAM in modern design and manufacturing
2. To impart the use of CAD in the design process
3. To impart the use of CAM in the production preparation process
4. Demonstrate the applications and limitations of different CAD/CAM system types

#	CONTENTS	Hrs
UNIT-1	**INTRODUCTION** Role of computers in design and manufacturing influence of computers in manufacturing environment. Product cycle in convention to computerized manufacturing environment. Introduction to CAD. Introduction to CAM. Advantages and disadvantages of CAD and CAM, curves and types.	**10**
UNIT-2	**STANDARD EXCHANGE FORMAT AND TRANSFORMATION** Software configuration of a graphic system. Function of graphics package, construction of geometry, wire frame and solid modeling, CAD/CAM integration. Desirable modeling facilities, Introduction to exchange of modeling data – basic features of IGES, STEP, DXF, DMIS.	**10**
UNIT-3	**INTRODUCTION TO ROBOTICS** Introduction, robot configuration, robot motion, programming of robots, end effectors work cell, control and interlock, sensor, robot applications. Kinematic Analysis – Direct and Inverse Kinematic analysis, problems.	**08**
UNIT-4	**NC, CNC, DNC TECHNOLOGIES** NC, CNC, DNC, modes. NC element, advantages and limitations of NC, CNC. Functions of computer in DNC. CNC tooling: Turning tool geometry, milling tooling system, tool presetting. ATC, work holding.	**12**
UNIT-5	**CNC MACHINING CENTERS** Introduction to CNC, elements of CNC, CNC machining centers, part programming, fundamental steps involved in development of part programming for milling and turning.	**12**

REFERENCE BOOKS

1. **Computer aided design (CAD) and computer aided manufacturing (CAM)** by Mikell Groover, Pearson Education INC, Fifth Impression, 2008.
2. **CAD/CAM** by P N Rao, Tata McGraw Hill, Sixth Reprint, 2006.
3. **CAD/CAM** by Ibrahim Zied, Tata McGraw Hill, Fourth Reprint, 2008.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each full question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES:

1. Understand the possible applications of the CAD/CAM systems in structure analysis, optimize and virtual engineering.
2. Demonstrate the basic fundamentals that are used to create, manipulate and analyse geometric models in a computer graphics.
3. To learn about Robot motions, sensors, end effectors Programming , kinematic analysis of robot
4. Explain the basic concepts, features of NC, CNC, DNC machines and machining centers.

MAPPING OF COs WITH POs

Co/PO's	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**K**	**l**
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2016-17 ACADEMIC YEAR: 2018-19
SEMESTER : FIFTH

COURSE TITLE : EXPERIMENTAL STRESS ANALYSIS (CORE ELECTIVE)		
Sub Code: ME551	**No of Credits : L-T-P-SS 3:0:0:0 =3**	**No. of lecture hours/week : 03**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Mechanics of materials**	

COURSE OBJECTIVES:

1. Analyze stresses within the elastic range in 3D.
2. Compile strains and displacements.
3. Evaluate stress and strain relations for linear elastic materials.
4. Demonstrate the experimental methods for analyzing stresses and strains in given specimen.
5. Develop photo-elastic, Moire techniques and holography methods for analysing stresses experimentally.

. #	CONTENTS	hr
UNIT-1	**PHOTOELASTICITY**	**06**
	Nature of light, Wave theory of light - optical interference, stress optic law – effect of stressed model in plane and circular polariscopes, isoclinics & isochromatics, Fringe order determination, determination of fractional fringe order, Babinet soleil componsation photo-elastic model materials. Application.	
UNIT-2	**TWO DIMENSIONAL PHOTOELASTICITY**	**07**
	Separation methods: Shear difference method, Analytical separation methods, Model to prototype scaling, Properties of 2D photo-elastic model materials, materials for 2D photo-elasticity.	
UNIT-3	**BRITTLE COATINGS**	**06**
	Coatings stresses, Crack patterns, Refrigeration techniques, Load relaxation techniques, Crack detection methods, Types of brittle coatings, Calibration of coating. Advantages and brittle coating applications.	
UNIT-4	**PHOTOELASTIC(BIREFRINGENT) COATINGS**	**10**
	Theory of Birefringence coating stresses, Sources of Error, Effects of coating thickness: Reinforcing effects, Poission's, Stress separation techniques: Oblique incidence, Strip coatings. Stress Freezing technique, Birefregent coating materials. **MOIRE METHODS:** Moire fringes produced by mechanical interference. Geometrical approach, out of plane displacement measurements, Applications and advantages.	
UNIT-5	**ELECTRICAL RESISTANCE STRAIN GAUGES**	**10**
	Gauged factors &Strain sensitivity in metallic alloys, Gauge construction, characteristics of strain gauges, Adhesives and mounting techniques, Gauge sensitivity and gauge factor,	

	Performance Characteristics, Environmental effects, Strain Gauge circuits. Wheatstone's Potentiometer bridges, Constant current strain gauge circuits. **STRAIN ANALYSIS METHODS:** Two element, three element rectangular and delta rosettes, stress-strain relations, correction for transverse strain effects.	

TEXT BOOKS:

1. "Experimental Stress Analysis", Dally and Riley, McGraw Hill.
2. "Experimental Stress Analysis". Sadhu Singh, Khanna publisher.
3. Experimental stress Analysis, Srinath L.S tata McGraw Hill.

REFERENCES BOOKS :

1. "PhotoelasticityVol I and VolII,M.M.Frocht, John Wiley & sons.
2. "Strain Gauge Primer", Perry and Lissner,
3. "Photo Elastic Stress Analysis", Kuske, Albrecht & Robertson John Wiley &Sons.
4. "Motion Measurement and Stress Analysis", Dave and Adams.

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each full question shall contain maximum of 3 subdivisions.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)

CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

COURSE OUTCOMES:

1. Analyze stresses within the elastic range of materials.
2. Compile strains and displacements
3. Evaluate stress and strain relations for linear elastic materials.
4. Describe the importance of experimental methods in analyzing stress and strain
5. Describe photo elastic, Moiré technique of experimental stress analysis Validate results with experiments.

ADMISSION YEAR : 2016-17 **ACADEMIC YEAR: 2018-19**
SEMESTER : FIFTH

COURSE TITLE : ADVANCED MANUFACTURING PROCESSES (CORE ELECTIVE)		
Sub Code: ME552	**No of Credits : L-T-P-SS 3:0:0:0 =3**	**No. of lecture hours/week : 03**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Manufacturing Process I & II**	

COURSE OBJECTIVES:

1. Discuss the finishing, super finishing and broaching process.
2. Explain the various types of non-traditional machining processes.
3. Explains the simple micro machining processes.
4. Know various techniques of metal joining processes.
5. Explains the metal forming processes.

#	CONTENTS	h
UNIT-1	**WELDING PROCESS**	**06**
	Definition, principles, classification, application, advantages & limitations of welding. arc welding: principle, Metal Arc welding (MAW), Flux Shielded Metal Arc Welding (FSMAW), Inert Gas Welding (TIG & MIG). **RESISTANCE WELDING:** Principles, Friction stir welding process, Laser beam welding, Ultrasonic welding. **PRINCIPLES OF SOLDERING & BRAZING:** Parameters involved & mechanism. Different types of soldering & brazing methods.	
UNIT-2	**METAL FORMING**	**07**
	Forming methods dies & punches, progressive die, compound die, combination die. rubber forming, open back inclinable press (OBI press), piercing, blanking, bending, deep drawing, LDR in drawing, Types of extrusion processes, extrusion equipment, extrusion dies, and extrusion of seamless tubes. Extrusion variables, simple problems. Classification of Rolling processes. Types of rolling mills, expression for rolling load, roll separating force, rolling variables, simple problems.	
UNIT-3	**BROACHING PROCESS, FINISHING AND SUPER FINISHING PROCESS**	**06**
	Principle of broaching. Details of a broach. Types of broaching machines-constructional details. Applications. Advantages and Limitations. Finishing and other processes, lapping and honing operations – principles, arrangement of set up and application. Super finishing process, polishing, buffing and application.	
UNIT-4	**MICROMACHINING**	**10**

	Micro machining processes-an introduction, molecular dynamic simulation of machining at the atomic scale, diamond turn machining, abrasive jet micro machining, magneto-rheological nano-finishing processes.	
UNIT-5	**NON-TRADITIONAL MACHINING PROCESSES**	**10**
	Need for nontraditional machining, principle, equipment & operation of Laser beam, Plasma arc machining, Electro chemical machining, Ultrasonic machining, Abrasive Jet machining, Water Jet machining, Electron beam machining, Electron discharge machining and Plasma arc machining.	

TEXT BOOKS:

"Manufacturing Process-I", Dr. K. Radhakrishna, Sapna Book House, 5th Re-vised Edition 2009.

1. **"Manufacturing & Technology:** Foundry Forming and Welding", P.N. Rao 2nd Ed., Tata McGraw Hill, 2003.
2. **Manufacturing Science,** Amitabha Ghosh and Mallik, affiliated East West Press, 2005.
3. **Manufacturing Process – III,** Dr. K.Radhakrishna, SapnaBook House, 2009.

REFERENCE BOOKS:

1. **"Manufacturing Technology",** Serope Kalpakjain, Steuen.R. Sechmid, Pearson Education Asia, 5th **Ed. 2006.**
2. **"Process and Materials of Manufacturing**", Roy A Lindberg, 4th Ed. Pearson Edu. 2006.
3. V.K.Jain, "**Introduction to Micro Machining**"
4. Narosa, 2010 JosephMc Geough, "**Micro machining of Engineering Materials**"
5. **Principles of Metal Casting",** Rosenthal, Tata McGraw Hill Publications.
6. **Mechanical Metallurgy** – Dieter, Tata McGraw Hill, 2001.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)

CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each full question shall contain maximum of 3 subdivisions.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	1	0	2	0	3	0	0	0	1	0	0	2
2	2	1	2	3	3	0	3	1	1	0	0	2
3	2	1	3	3	3	2	2	1	2	0	0	1
4	2	1	2	3	1	1	2	1	1	0	0	1
5	2	0	3	2	3	3	2	0	2	1	0	2

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2016-17 ACADEMIC YEAR: 2018-19
SEMESTER : FIFTH

COURSE TITLE : POWER PLANT ENGINEERING (CORE ELECTIVE)		
Sub Code: ME553	**No of Credits : L-T-P-SS 3:0:0:0 =3**	**No. of lecture hours/week : 03**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	Thermodynamics, Fluid Mechanics, Turbo Machines	

Course objectives:

1. To familiarize with different conventional and non-conventional energy sources
2. To demonstrate layout and components of steam power plants, diesel engine power plants, hydroelectric power plants, nuclear power plants.
3. To implement principles of power generation through solar energy, wind energy, ocean, tidal energy & fuel cells.
4. To apply basic calculations to understand design principles of conventional energy conversion.
5. To demonstrate competence in understanding performance of energy conversion devices through experiments.

#	**CONTENTS**	**Hrs**
UNIT-1	**THERMAL POWER PLANTS**	**7**
	Introduction: Energy sources for generation of electric power, energy policy of India, present status and future trends, major power plants in India. Thermal Power Plants: Selection of site, general layout of the plant, major components- Boilers, Economizers, Super-heaters, Air pre-heaters, fuels, fuel and ash handling equipment, High pressure Boilers, steam turbines, station heat balance and plant efficiency.	
UNIT-2	**DIESEL ENGINE POWER PLANT**	6
	Introduction; Applications of Diesel Engines in power field Advantages and disadvantages diesel engine power plant, Types, General layout, Combustion in a CI engine, Performance characteristics, Supercharging, Layout of diesel engine power plant, Numericals.	
UNIT-3	**HYDROELECTRIC POWER PLANTS**	6
	Introduction; Classification of hydro-plants, selection of site, rain fall and run off, calculation of storage capacity, plant layout estimation of power available, selection of hydraulic turbines and their governing, general layout of hydro power plant.	
UNIT-4	**NUCLEAR POWER PLANT**	10
	Nuclear Power Plants: Introduction, Atomic structure and radio-activities nuclear reactions, binding energy, Nuclear Reactors, Types of reactors, Pressurized water reactors, boiling heater reactors, Heavy water-cooled and moderated (CANDU) reactor, Gas cooled reactors, Liquid metal cooled reactors, Indian Nuclear power installations, comparison between Nuclear and Thermal plants, Numericals.	
UNIT-5	**NON CONVENTIONAL POWER GENERATION**	**10**
	Introduction, Direct energy conversion, MHD, Thermionic and Thermoelectric power generation, Fuel cells, Geothermal energy, Hydrogen energy systems, Numericals.	

TEXT BOOKS

1. **Power Plant Engineering**, P. K. Nag, Tata McGraw Hill, 4 Edition, 2014.
2. **A Text Book of Power Plant Engineering,** R. K. Rajput, Laxmi publication, New Delhi, 4 Edition, 2007.

REFERENCE BOOKS

1. **Power Plant Engineering,** G.R. Nagpal and S.C. Sharma, Khanna Publishers,16 Edition, 2012.

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each full question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES:

After completion of the course, students will be able to:

1. Recognize different conventional and non-conventional energy sources.
2. Describe the layout and components of Steam power plants, diesel engine power plants, hydroelectric power plants, nuclear power plants
3. Explain principles of power generation through solar energy, wind energy, ocean tidal energy and fuel cells.
4. Apply basic calculations to understand design principles of conventional and non-conventional energy conversion
5. Compare advantages & limitations of conventional and non-conventional energy sources.
6. Demonstrate competence in understanding performance of energy conversion devices through experiments

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	2	1	1	1
2	3	3	2	1	2	1	1	1	2	2	1	1
3	3	3	3	1	2	1	1	1	2	2	1	1
4	3	3	2	1	2	1	1	1	2	2	1	1
5	3	3	3	1	3	1	1	1	3	2	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : **2016-17** **ACADEMIC YEAR: 2018-19**
SEMESTER : **FIFTH**

COURSE TITLE : THEORY OF ELASTICITY		
Sub Code: ME561	**No of Credits : L-T-P-SS 3:0:0:0 =3**	**No. of lecture hours/week : 03**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Mechanics of materials, Design of machine elements**	

COURSE OBJECTIVES:

1. To study the basic concept of stresses, stress distribution, elastic constants when the material is subjected to loading within the elastic limits
2. Study the stress distribution in plane, polar and cylindrical coordinate systems
3. Analyze the material or component subjected to torsion of circular and non-circular shafts (elliptical, triangular bars)
4. Study the thermo-elastic properties of the material at elevated temperatures.

#	CONTENTS	Hrs
UNIT-1	**DEFINITION AND NOTATION:** Stress, Stress at a Point, Equilibrium Equations, Principal Stresses, Mohr's Diagram, Maximum Shear Stress, Boundary Conditions. **T**he three theorem's -theorem of virtual work, theorem of least work, Castigliano's theorem, Rayleigh Ritz method, Galekin's method, Elastic behaviour of anisotropic materials like fibre reinforced composites **STRAIN AT A POINT:** Equilibrium Equations, Principal Stresses, Compatibility Equations, Principal Strains, Generalized Hooke's law, Maximum Shear Stress, Boundary Conditions. Methods of Solution of Elasticity Problems – Plane Stress-Plane Strain Problems**.**	10
UNIT-2	**TWO DIMENSIONAL PROBLEMS**: Cartesian co-ordinates – Airy's stress functions – Investigation of Airy's Stress function for simple beam problems – Bending of a narrow cantilever beam of rectangular cross section under edge load – method of Fourier analysis – pin ended beam under uniform pressure. **GENERAL EQUATIONS IN CYLINDRICAL CO-ORDINATES:** Thick cylinder under uniform internal and / or external pressure, shrink and force fit, stress concentration.	10
UNIT-3	**THERMAL STRESSES:** Thermo elastic stress strain relationship, Equations of equilibrium Thermal stresses in thin circular discs and in long circular cylinder, sphere.	08
UNIT-4	**STRESSES IN AN INFINITE PLATE:** (with a circular hole) subjected to uniaxial and biaxial loads, stress concentration, stresses in rotating discs and cylinders. **PLATE BENDING:** Bending of plate to cylindrical surface, bending of a long uniformly loaded rectangular plate, pure bending in two perpendicular directions, bending of circular plates loaded symmetrically w. r. t. centre, Bending of circular plates of variable thickness, circular plate with circular hole at centre symmetrically loaded and load distributed along inner and outer edges	12

	TORSION OF CIRCULAR, ELLIPTICAL AND TRIANGULAR BARS: membrane analogy, torsion of thin open sections and thin tubes.	
UNIT-5	**UNIQUENESS THEOREM:** Principle of super position, reciprocal theorem, saint venant principle. **EXPERIMENTAL STRESS ANALYSIS:** Dimensional analysis, analysis techniques strain gauges: configuration, instrumentation, characteristics of strain gauge measurement. Theory of photo elasticity and techniques used in Photo elastic application. **FRACTURE MECHANICS:** Introduction to Linear Elastic Fracture Mechanics, Modes of fractures, Stress intensity factor, crack initiation and Crack opening phenomenon, stress distribution around crack tip under various loading conditions, Fracture toughness GIc Plastic bending of elastic materials.	**1**2

TEXT BOOKS:

1. **Advanced Mechanics of solids**, L. S. Srinath, Tata Mc. Graw Hill, 2003
2. **Theory of Elasticity,** S. P. Timoshenko and J. N Gordier, Mc.Graw Hill International, 3rd edition, 1972

REFERENCES BOOKS:

1. **Theory of Elasticity,** Dr. Sadhu Singh, Khanna Publications, 1988
2. **Elasticity, Theory, Applications &Numericals,** Martin H Sadd, Elsevier. 2005
3. **Applied Elasticity,** Seetharamu &Govindaraju, Interline Publishing
4. **Applied Elasticity,** C.T. WANG Sc. D. Mc. Graw Hill Book Co.1953.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)
(Irrespective of portions covered due to whatever might be the reason)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each full question shall contain maximum of 2 subdivisions.

COURSE OUTCOMES: Learner will be able to

1.Make the students to understand the concept of elastic and plastic behavior of the material
2.Analyze the stress and strain tensors at a point in a member subjected to loading (point/distributed)
3.Applying the concept of compatibility and equilibrium conditions to analyze the stress and strain tensors
4.Study the thermo-elastic properties of the material at elevated temperatures and analyzing the stress concentration factor of a structural component subjected to different types of load

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	2	2	3	3	2	3	3	1	2
CO2	2	3	3	2	2	1	3	2	3	3	3	2
CO3	3	3	3	2	3	2	3	1	3	2	3	2
CO4	3	3	2	2	3	2	3	1	2	2	3	3

- High-3
- Medium-2
- Low-1

ADMISSION YEAR : 2016-17 **ACADEMIC YEAR: 2018-19**
SEMESTER : FIFTH

COURSE TITLE : COMPOSITE MATERIALS AND MANUFACTURING (CORE ELECTIVE)		
Sub Code: ME562	**No of Credits : L-T-P-SS 3:0:0:0 =3**	**No. of lecture hours/week : 03**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites		

COURSE OBJECTIVES:

The objective of this course is to provide students an opportunity to develop the knowledge base and skills necessary.

1. To understand the capabilities and limitations of existing materials, processes and property enhancement mechanisms.
2. To understand the fundamentals of composite material strength and its mechanical behavior and analysis of fiber reinforced Laminate design for different combinations of plies with different orientations of the fiber.
3. To provide opportunity for improvements, select materials and processes to best suit specific applications.
4. To enhance knowledge on processing, interfacial properties and application of composites.
5. To predict the elastic properties of both long and short fiber composites based on the constituent properties.

Unit	Contents	Hours
Unit-1	**INTRODUCTION**	07
	General introduction to composites; historical background; concept of matrix and reinforcement and particulate. **MATRIX AND REINFORCEMENT** Types of matrix and reinforcement, volume fraction and mass/weight fraction , density, void content, load, stresses, young's modulus determination, fiber architecture, fiber packing arrangements, whiskers. Numerical Problems on calculation of volume fraction, weight fraction, density, void content, stresses and young's modulus.	
Unit-2	**TESTING, CHARACTERIZATION and SECONDARY PROCESSESS**	06
	Different tests tensile, compression, shear, fatigue, pull-out test, fracture toughness, metallographic preparation etc. with special emphasis to metal matrix composites, XRD and SEM. **Secondary Processes and Applications:** Secondary processing like machining, joining, extrusion of composites - Application and case studies.	
Unit-3	**SMART MATERIALS**	06

	Introduction and properties of piezoelectric materials shape memory, alloys, ER and MR fluids, electrostrictive and magntostrictive materials as smart materials, applications.	
Unit-4	**FABRICATION METHODS OF POLYMER COMPOSITES, METAL MATRIX COMPOSITES**	10
	Polymer Composites: Open and closed mould process, hand layup techniques, structural laminate bag molding, Liquid resin impregnated routes, pressurized consolidation of resin, pre-pegs, consolidation of resin molding compounds, injection molding of thermoplastics, hot press molding of thermoplastics, filament winding, pultrusion, pulforming. **Metal Matrix:** Squeeze infiltration, stir casting, and spray deposition, powder blending and consolidation, diffusion bonding of foils, PVD.	
Unit-5	**FABRICATION of CERAMIC COMPOSITES AND MICROMECHANICS OF COMPOSITES**	10
	Ceramic Composites: Powder based routes, reactive processing, layered ceramic composites, and carbon/carbon composites. **Micromechanics of composites:** Density, Mechanical properties; Prediction of Elastic Constants, Micromechanical Approach, Halpin-Tsai equations, Transverse Stresses. Thermal Properties: Expression for Thermal Expansion Coefficients, Expression for Thermal Conductivity of Composites, Hygral and Thermal Stresses. Mechanics of Load Transfer from Matrix to Fiber; Fiber elastic-Matrix elastic, Fiber elastic-Matrix Plastic. Load Transfer in Particulate Composites. Numerical Problems.	

TEXT BOOKS:

1. S.C.Sharma Composite materials Narosa Publishers.
2. Manoj Kumar Buragohain, Composite Structures: Design, Mechanics, Analysis, Manufacturing, and Testing; CRC Press, 2017
3. Srinivasan K; Composite Material: Production Properties Testing; Narosa Publishers; 2009.
4. Autar K Kaw, Mechanics of Composite Materials, CRC, Taylor & Francis Group, 2006.

REFERENCE BOOKS:

1. R.K.Everret& R.J. Arsenault Metal matrix composite Academic press.
2. T. W. Clyne& P. J. Withers Introduction to metal Matrix Composite Cambridge press

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)
(Irrespective of portions covered due to whatever might be the reason)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3		4		5

SCHEME OF EXAMINATION (SEE) (Question Paper Pattern)

1. Seven full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-2 and Unit-3 are compulsory, with one full question from each Unit.
4. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.

COURSE OUTCOMES:

On completion of the course, student should be able to;

1. Analyze the properties of matrix material, particulates and fibers of polymer matrix composites, MMC and ceramic matrix composites and ability to identify the properties of fiber and matrix materials used in commercial composites.
2. Know the mechanism of how a smart works and selection of a smart material for specific applications.
3. Select suitable testing procedures, characterization of composite materials and knowledge of secondary processing of composites.
4. Select suitable fabrication processes for fiber reinforced, metal matrix composites and ceramic composites.
5. Solve numerical problems based on micromechanics of composites.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2016-17 **ACADEMIC YEAR: 2018-19**
SEMESTER : FIFTH

COURSE TITLE : HEATING, VENTILATION AND AIR CONDITIONING (CORE ELECTIVE)		
Sub Code: ME563	**No of Credits : L-T-P-SS 3:0:0:0 =3**	**No. of lecture hours/week : 03**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Basic & Applied thermodynamics, Heat transfer, Refrigeration**	

COURSE OBJECTIVES:

1. To understand concept of Psychrometry and explain various air conditioning processes.
2. To explain design conditions for human comfort and critical loading conditions.
3. To calculate the various cooling loads to select the air conditioning apparatus..
4. To understand the various heat sources for optimal design of dehumidifying coils and another air conditioning apparatus.
5. To design the air ducts for proper ventilation and distribution of clean air through the air conditioned space.

#	Contents	h
UNIT-1	**PSYCHROMETRY**	**06**
	Introduction to air conditioning: Brief history, Working substance, Psychrometric properties, Wet bulb temperature, Adiabatic saturation, Psychrometric chart, Application of I law to Psychrometric process; Psychrometry of air conditioning processes – Mixing process, Basic processes, Psychrometric processes in air conditioning equipment, Simple air conditioning, Summer and winter air conditioning system, Apparatus Dew Point, Numericals	
UNIT-2	**DESIGN CONDITIONS**	**06**
	Introduction; Choice of inside design conditions, Comfort, Outside design conditions, Choice of supply design conditions, Critical loading conditions, Clean spaces; Heat transfer through building structures, Overall heat-transmission coefficient, Empirical methods to evaluate heat transfer through walls and roofs, Natural ventilation through infiltration, Passive heating and cooling of buildings, Water vapour transfer through structures, Numericals.	
UNIT-3	**LOAD CALCULATIONS**	**07**
	Introduction; Preliminary considerations, Internal heat gains, System heat gains, Break-up of ventilation load and effective sensible heat factor, Cooling load and heating load estimate, Psychrometric calculations for cooling, Selection of air conditioning apparatus for cooling and dehumidification, evaporative cooling, Building requirements and energy conservation in air conditioned buildings, Numericals	
UNIT-4	**DESIGN OF AIR CONDITIONING APPARATUS**	**10**
	Introduction: Heating systems – warm air systems – hot water systems – steam heating systems – panel and central heating systems, Heat pump circuit, heat sources for heat pump. Air conditioning apparatus, Heat and moisture transfer, Design of cooling and dehumidifying coils, Optimal design, Design of air washers and cooling towers, Numericals.	

UNIT-5	TRANSMISSION AND DISTRIBUTION OF AIR	10
	Introduction: Room air distribution, Total, static and velocity pressures, Friction and dynamic loss in ducts, Air flow through simple duct system, Air-duct design, Processing, transmission and distribution of air in clean rooms, Air locks, Air curtains and Air showers, Numericals.	

TEXT BOOKS:

1. **Refrigeration and Air Conditioning,** C.P. Arora, McGraw-Hill Education (India) Pvt. Limited, 3rd Edition, 2009.
2. **Refrigeration and Air Conditioning,** Manohar Prasad, New Age International (P) Limited Publishers, 3rd Edition, 2015.

REFERENCE BOOKS

1. **Hand Book Air Conditioning and Refrigeration,** Shan K Wang, 2nd Edition, McGraw-Hill Publications, 2000.
2. **Refrigeration and Air Conditioning,** W.F. Stoecker, and J.W. Jones, 2nd Edition, Tata McGraw-Hill Publications, 1982.
3. **ASHRAE Handbook- Fundamentals,** American Society of Heating, Refrigerating and Air-Conditioning, Engineers Inc., Atlanta, USA, 1997.

DATA HAND BOOKS AND CHARTS

1. **Refrigeration Tables and Charts: SI Units,** C.P. Kothandaraman**,** 4th Edition, New Age International Publishers, 2015.

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each full question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES: On completion of the course, student should be able to;

1: Describe the properties of moist air, design conditions and load calculations for heating, ventilation and air conditioning purposes.
2: Distinguish the various air conditioning system and heat gains, used in the design conditions.
3: Solve problems related to application of various air conditioning apparatus and transmission and distribution of air.
4: Analyse the design conditions and load calculations for the given air conditioning apparatus.
5: Derive mathematical expressions and equations to determine the various design and load parameters in designing the air conditioning equipment.
6: Calculate the Psychrometric properties, critical loading conditions, system heat gains, air flow rates in various air conditioning equipment.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2016-17 ACADEMIC YEAR: 2018-19
SEMESTER : FIFTH

COURSE TITLE : HEAT TRANSFER LABORATORY		
Sub Code: MEL57	**No of Credits : L-T-P-SS 0:0:2:0 = 1**	**No. of lecture hours/week : 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 50**
Pre-requisites	**Basic Thermodynamics, Fluid Mechanics, Heat Transfer**	

COURSE OBJECTIVES:
1. To understand the basic conduction, convection and radiation heat transfers.
2. To study combined conduction and convection states of heat transfer.
3. To determine emissivity of a grey body and verify Stefan Boltzmann constant.
4. To determine effectiveness of parallel flow and counter flow heat exchangers.
5. To conduct tests on vapor compression refrigeration.

#	CONTENTS	h
UNIT-1	**MINOR EXPERIMENT**	**10**
	1. Composite wall - Determination of overall heat transfer coefficient of a composite wall. 2. Metal rod - Determination of thermal conductivity of a metal rod. 3. Fin – Determination of efficiency and effectiveness of a fin free convection mode. 4. Emissivity - Determination of emissivity of a given grey surface	
UNIT-2	**MAJOR EXPERIMENT**	**16**
	1. Vertical pipe - Determination of heat transfer coefficient in free convection mode. 2. Pipe flow - Determination of heat transfer coefficient in forced convection mode for hot air flowing through a circular pipe. 3. Stefan Boltzmann constant - Verification of Stefan Boltzmann Constant. 4. Fin - Determination of efficiency and effectiveness of a fin in forced convection mode. 5. Shell and Tube heat exchanger - Determination of Log Mean Temperature Difference (LMTD) and Effectiveness in (i) Parallel Flow mode and (ii) Counter Flow mode 6. Vapour Compression Refrigerator (VCR) – Determination of COP.	

REFERENCE BOOKS
1. **Heat and Mass Transfer,** P.K. Nag, 3rd Edition, Tata McGraw-Hill, 2011.
2.A Course in Heat and Mass Transfer, Domkundwar, Arora, Domkundwar, DhanpatRai Publications, 2005.
3.Basic and Applied Thermodynamics, P.K. Nag, Tata McGraw-Hill Publications, 2nd Edition, 2010.

SCHEME OF EXAMINATION (SEE)

Sl. No.	Particulars	Max. Marks	Break Up of Max. Marks		
			Write Up	Conduction of experiment	Specimen Calculation, Tabulation of Results and Plotting of Graph
1	**Unit-1: Minor Experiment** (Any ONE from the list of experiments)	**15**	05	05	05
2	**Unit-2: Major Experiment** (Any ONE from the list of experiments)	**25**	05	10	10
3	Viva Voce	**10**	--	--	--
	TOTAL MARKS	**50**	**10**	**25**	**15**

COURSE OUTCOMES: On completion of the course, student should be able to;
After completion of the course, students will be able to:
1: Identify the equipment used for illustrating various modes of heat transfer.
2: Explain the various modes of heat transfer and heat transfer devices with examples and illustrations.
3: Demonstrate the working of equipment used in the laboratory.
4: Illustrate the procedure used to conduct the experiment with equipment.
5:Analyse the expressions to determine the heat transfer rate from various modes of heat transfer.
6: Calculate the rate of heat transfer in different equipment and plot the results of various heat transfer systems.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : **2016-17** **ACADEMIC YEAR: 2018-19**
SEMESTER : **FIFTH**

COURSE TITLE : FUEL TESTING AND INTERNAL COMBUSTION ENGINES LABORATORY		
Sub Code: MEL58	**No of Credits : L-T-P-SS 0:0:2:0 = 1**	**No. of lecture hours/week : 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 50**
Pre-requisites	**Basic Thermodynamics, Applied Thermodynamics**	

COURSE OBJECTIVES

1. To conduct tests on oils to determine flash, fire points and viscosity.
2. To determine calorific value of a given fuel.
3. To plot the valve timing diagram of 2-stroke and 4-stroke IC engine.
4. To calculate the area of an irregular shape using planimenter.
5. To conduct performance test on petrol and diesel IC engine and evaluate the power produced and efficiencies.
6. To conduct Morse test on 4-stroke multi cylinder engine to determine the utility heat input and draw heat balance sheet

UNIT	**Syllabus**	**Hrs**
1.	**MINOR EXPERIMENTS** (i) Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Martin (closed) **(or)** Cleave land (Open Cup) Apparatus. (ii) Determination of Calorific value of solid, liquid and gaseous fuels. (iii) Determination of Viscosity of lubricating oil using Redwoods Saybolts and Torsion Viscometers. (iv) Valve Timing of a four stroke I.C. engine. **(or)** port opening diagram of an 2 stroke I.C. engine. (v) Use of planimeter	**10**
2.	**MAJOR EXPERIMENTS** Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal efficiencies, SFC, FP, heat balance sheet for (i) Four stroke Diesel Engine (ii) Four stroke Petrol Engine (iii) Two stroke Petrol Engine (iv) Morse test to evaluate the friction power in Multi Cylinder Diesel/Petrol Engine	**16**

REFERENCE BOOKS

1. Basic and Applied Thermodynamics, P.K. Nag, Tata McGraw-Hill Publications, 2nd Edition, 2010.
2. Internal Combustion Engines, V Ganeshan, Tata McGraw-Hill Publications, 4th Edition, 2012.

Sl. No.	Particulars	Max Marks	Break up Max. Marks		
			Write up	Conduction of experiment	Calculations, Results and graphs
1	**MINOR EXPERIMENTS** Any one from list of experiments	15	5	5	5
2	**MAJOR EXPERIMENTS** Any one from list of experiments	25	5	10	10
3	**Viva Voice**	10	-	-	-
		50	10	15	15

COURSE OUTCOMES: On completion of the course, student should be able to

1. Conduct basic tests on lubricating oil like fire, flash, cloud and pour points along with viscosity.
2. Determine calorific values of all types of fuels.
3. Plot internal combustion engine valve timing diagrams.
4. Calculate the area of irregular shapes using Planimeter.
5. Test the various engines for their performance.
6. Calculate the efficiency of engines.

MAPPING OF COs WITH Pos

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2016-17 ACADEMIC YEAR : 2018-19
SEMESTER : SIXTH

COURSE TITLE : DESIGN OF MACHINE ELEMENTS – II		
Sub Code: ME61	**No of Credits : L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week : 04**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites		

COURSE OBJECTIVES:

1. The student shall gain appreciation and understanding straight and curved beams and general applications of curved beams such as machine frame, punching machine and crane hook, bending and resultant stress occurs at various symmetrical and non-symmetrical crass sections and extended chain links used for curved beams.
2. The student shall be able to understand functions of various spring and its application, types of springs, such as helical, spiral, buffer, concentric and leaf springs and stress induced, deflection, energy stored in the spring, design procedure, selection of suitable material to design and design springs for various suitable applications.
3. The student shall be able to understand meaning of gear drive importance of gear drive, various fields of applications, general classifications, general characteristics, requirements of gear drive, types of tooth profile ,loads, selection of suitable material for gear design stress acting on gears and design procedure to design a different gears for various applications,
4. The student shall be able to understand functions of lubrications, desirable properties, types of lubrications system, selection proper grade of lubrication for particular application, and also to understand functions of bearing, general classification, design procedure to design any bearing, selection of various factors for bearings, determination of life of bearing, selection of proper grade of lubrication suitable and heat generated, heat dissipated etc.

#	**CONTENTS**	**Hrs**
UNIT-1	**CURVED BEAMS**: Assumptions made in the analysis of curved beams: Design of curved beams: Bending stresses and resultant normal stress in curved beams of standard cross sections used in crane hook, punching presses & clamps, closed rings and links. Numericals **THICK CYLINDERS**: Design of thick cylinders subjected to an internal pressure using Lame's equation. Numericals	08
UNIT-2	**SPRINGS**: Introduction, classification of springs - stresses in helical coil springs of circular sections, Energy stored in springs, and problems on helical coil springs., Concentric springs, advantages and applications and design of concentric springs under fluctuating loads, Leaf Springs, advantages and applications, classifications: Stresses in leaf springs. Equalized stresses in springs.	12

UNIT-3	**POWER TRANSMISSION:** **SPUR GEAR DRIVES:** Iintroduction, classification, advantage, dis-advantages and applications, terminology of spur gears, material selection for spur gear design, stresses in gear tooth: Lewis equation and form factor, Estimation of centre distance, module and face width, Check for dynamic and wear load considerations and numerical problems on spur gear. **HELICAL GEARS:** Introduction, classification, advantage, dis-advantages and applications, terminology of helical gears, formative number of teeth, material selection for helical gear design, stresses in gear tooth: Lewis equation and form factor, Estimation of centre distance, module and face width, Check for dynamic and wear load considerations and numerical problems on spur gear.	12
UNIT-4	**BEVEL GEARS**: Introduction, classification, advantage, applications, terminology of bevel gears, formative number of teeth, material selection for bevel gear design, stresses in gear tooth: Lewis equation and form factor, Design for strength, Dynamic load and wear load, problems on bevel gear. **WORM GEARS**: Introduction, classification, advantage, applications, terminology of worm gears, material selection for worm gear design, stresses in gear tooth: Lewis equation, Design for strength, Dynamic load and wear loads and efficiency of worm gear drives and Numerical problems on worm gears.	10
UNIT-5	**LUBRICATION:** Introduction to Lubrication and their properties, types of lubrication, Mechanisr Lubrication, bearing modulus, coefficient of friction, minimum oil film thickness, generated, Heat dissipated. Types and selection of Mechanical Seals. **BEARINGS:** Classification, Bearing Materials, Types of bearing and designation, Selection of rolling contact bearings based on constant / variable load & speed conditions (includes deep groove ball bearing, cylindrical roller, spherical roller, taper roller, self-aligning bearing and thrust bearing). Design of ball bearing and journal bearing. Thrust bearings. Numerical problems**.**	10

TEXT BOOKS

1. **Mechanical Engineering Design**, Joseph E Shigley and Charles R. Mischke. McGraw Hill International edition, 6th Edition 2003.
2. **Design of Machine Elements**, V. B Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2007.

REFERENCE BOOKS

1. Machine Design, Robert L. Norton, Pearson Education Asia, 2001.
2. Design of Machine Elements, M. F. Spotts, T. E. Shoup, L. E. Hornberger, S. R. Jayram and C. V. Venkatesh, Pearson Education, 2006.

3. Machine Design, Hall, Holowenko, Laughlin (Schaum's Outlines series) Adapted by S.K. Somani, Tata McGraw Hill Publishing Company Ltd., New Delhi, Special Indian Edition, 2008.
4. Machine Design, A CAD Approach: Andrew D DIMAROGONAS, John Wiley Sons, Inc, 2001.

DESIGN DATA HANDBOOK

1. **Design Data Hand Book**, K. Lingaiah, McGraw Hill, 2nd Edition.
2. **Data Hand Book,** K. Mahadevan and Balaveera Reddy, CBS Publication
3. **Design Data Hand Book,** H.G. Patil, ShriShashi Prakashan, Belgaum.

SYLLABUS COVERAGE FOR CIE-1,2,3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (Firs100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2		3		4	5

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q6 and Q7 from Unit1, Unit 4 and Unit 5 respectively without choice.
2. Students shall answer Q2 or Q3 from Unit 2 and Q4 or Q5 from Unit 3.
3. Each full question shall contain maximum of 2 subdivisions.

COURSE OUTCOMES: Learner will be able to

1. Define basic concepts of vibration of bodies having one, two and multi degree freedom
   Develop basic mathematical models and Estimate natural frequency of mechanical element/system for undamped and damped mechanical SDOF systems.
2. Discuss equations of motion Analyze vibratory response of mechanical element/system for free undamped and damped and forced vibration response and estimate the parameters of vibration isolation systems for industrial environment.
3. Ability to find vibration parameters numerically by 2-degree and multi degree freedom by various numerical techniques
4. Explore modern vibration measuring instruments. Condition monitoring of working machineries

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	2	2	3	0	3	3	1	3	2
CO2	3	3	3	2	1	3	3	0	3	2	3	2
CO3	3	3	2	3	3	0	3	0	3	2	3	2
CO4	3	3	1	3	3	3	2	1	2	3	2	3

High-3 Medium-2 Low-1

ADMISSION YEAR : 2016-17 ACADEMIC YEAR : 2018-19
SEMESTER : SIXTH

COURSE TITLE : FINITE ELEMENT METHODS		
Sub Code: ME62	**No of Credits : L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week : 04**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Engineering mathematics, MOM, DOM**	

COURSE OBJECTIVES:
1. To impart structures analysis for stress, strain & dynamic loading knowledge
2. To enable formulation of the design problems into FEA.
3. To comprehend the basic concepts and enhance capabilities for solving complex problems.
4. To introduce the concepts of elastic and static analysis problems.

#	CONTENTS	h
UNIT-1	**INTRODUCTION**	**08**
	Equilibrium equations in elasticity subjected to body force, traction forces, and stress-strain relations for plane stress and plane strains. General description of Finite Element Method, Application and limitations. Types of elements based on geometry. Node numbering, Half band width. , Meshing & Meshing quality like wrap angle, aspect ratio, skew, Jacobian distance, Taper chord deviation **BASIC PROCEDURE**: Euler - Langrange equation for bar, beam (cantilever / simply supported fixed) Principle of virtual work, principle of minimum potential energy, Raleigh's Ritz method. Direct approach for stiffness matrix formulation of bar element. Galerkin's method boundary conditions and general comments.	
UNIT-2	**INTERPOLATION MODELS**	**12**
	Interpolation polynomials- Linear, quadratic and cubic. Simplex complex and multiplex elements.2D PASCAL's triangle. CST elements-Shape functions and Nodal load vector, Strain displacement matrix and Jacobian for triangular and rectangular element. **SOLUTION OF 1-DIMENSIONAL BARS:** Solutions of bars and stepped bars for displacements, reactions and stresses by using penalty approach and elimination approach. Guass-elimination technique. Applications	
UNIT-3	**HIGHER ORDER ELEMENTS**	**10**
	Lagrange's interpolation, Higher order one dimensional elements-Quadratic and cubic element and their shape functions. Shape function of 2-D quadrilateral element-linear, quadric element Iso-parametric, Sub parametric and Super parametric elements.	
UNIT-4	**TRUSSES**	**10**
	2D truss Elements Stiffness matrix of Truss element. Examples illustrating how to obtain various internal force diagrams for different types of structural member like trusses Numerical problems.	
UNIT-5	**BEAMS**	**12**
	Governing Differentia Equation for beam bending Hermite shape functions for beam element, Derivation of stiffness matrix. Numerical problems of beams carrying concentrated, UDL and linearly varying loads.	

TEXT BOOKS:

1. **Finite Elements in Engineering**, T.R.Chandrupatla, A.D Belegunde, 3rd Ed PHI.
2. **Finite Element Method in Engineering**, S.S. Rao, 4th Edition, Elsevier, 2006.

REFERENCE BOOKS:

1. **“Finite Element Methods for Engineers”** U.S. Dixit, Cengage Learning, 2009.
2. **Concepts and applications of Finite Element Analysis**, R.D. Cook D.S Maltus, M.E Plesha, R.J.Witt, Wiley 4th Ed, 2009
3. **Finite Element Methods**, Daryl. L. Logon, Thomson Learning 3rd edition, 2001.
4. **Finite Element Method**, J.N. Reddy, McGraw -Hill International Edition.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven Full Questions to be set.
2. Five full Questions to be answered.
3. Unit-1, Unit-3 and Unit-4 are compulsory, with one question from each Unit.
4. Unit-2 and Unit-5: Two questions to be set with choice.

COURSE OUTCOMES: on completion of the course, student should be able to;

1. To teach the students about the concepts of FEM and FEA.
2. Develop the knowledge to analyze structures under static and dynamic conditions.
3. Identify the numerical techniques for solving engineering problems using FEM.
4. Identify types of elements such as higher order, beams, and trusses for different applications.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2016-17 ACADEMIC YEAR : 2018-19
SEMESTER : SIXTH

COURSE TITLE : MECHANICAL VIBRATIONS		
Sub Code: ME63	**No of Credits : L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week : 04**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Engineering physics, DOM**	

COURSE OBJECTIVES:

1.To study basic concepts of vibration analysis and observe, analyze, understand the concept of vibrations in mechanical systems , various technique to solve single degree freedom and single dof without damping with damping, 2-degree, forced vibration and, Estimate natural frequency of mechanical system multi degree freedom system using various numerical techniques.
2.To acquaint with the principles of vibration measuring instruments
3. To recognize how to apply theory of vibration to engineering problems.
4. To study balancing of mechanical systems, and able to mathematically formulate real-world vibration problems in engineering.

#	CONTENTS	Hrs
UNIT-1	**BASIC CONCEPTS OF VIBRATION** Vibration and oscillation, causes and effects of vibrations, Vibration parameters – spring, mass, damper, Damper models, Motion – periodic, non-periodic, harmonic, non-harmonic, Degree of freedom, static equilibrium position, Vibration classification, Steps involved in vibration analysis. Definitions, Simple Harmonic Motion (S.H.M.), Work done by harmonic force, Principle of super position applied to SHM, Beats. **FREE UNDAMPED SINGLE DEGREE OF FREEDOM VIBRATION SYSTEM** Longitudinal, transverse, torsional vibration system, Methods for formulation of differential equations by Newton, Energy, Lagrangian and Rayleigh's Method, Different methods of determination of natural frequencies of simple systems, Springs in series and parallel, Torsional and transverse vibrations, Effect of mass of spring.	10
UNIT-2	**FREE DAMPED SINGLE DEGREE OF FREEDOM VIBRATION SYSTEM:** Types of damping**,** Analysis with viscous damping - Derivations for over damped, critically damped and under damped systems, Logarithmic decrement and numericals. **Rotor Dynamics:** Critical speed of single rotor, undamped and damped vibrations and numerical.	10
UNIT-3	**SYSTEMS WITH TWO DEGREES OF FREEDOM:** Principle modes and normal modes of vibrations, natural frequencies of systems (without damping) – Simple spring mass systems, torsional systems, combined rectilinear and angular systems, geared semi-defined systems, semi-definite systems and numericals. Dynamic vibration absorber.	08

UNIT-4	**FORCED VIBRATIONS:** Introduction**,** Analysis of forced vibration with constant harmonic excitation - magnification factor, rotating and reciprocating unbalances, support excitation for relative and absolute amplitudes, force and motion transmissibility. **Vibration Measurement**: Principle of seismic instruments, vibrometer, accelerometer - undamped, damped, Frequency measuring instruments, FFT analyser, vibration exciters, signal analysis. Time domain & Frequency domain analysis of signals. Numerical on seismic instruments. **Introduction to Conditioning Monitoring and Fault Diagnosis**.: At least one case studies in detail based on Conditioning Monitoring and Fault Diagnosis.	12
UNIT-5	**NUMERICAL METHODS FOR MULTI DEGREE FREEDOM OF SYSTEMS**: **(i)(A) Free Undamped Multi Degree Freedom System:** Introduction, Maxwell's reciprocal theorem, Influence coefficients, Orthogonality of principal modes, Introduction to Modal analysis**.** **(B) Multi Degree System Numerical Methods:-** (i) Rayleigh`s Method, (ii) Dunkerley's method (iii) Stodola method (iv) Holzer`s Method (v) Methods of Matrix iterations (v) Eigen Values Eigen Vector problems. Modal Analysis. Impulse response and frequency Response functions. Two rotors, Three rotors and geared system. No numericals	12

TEXT BOOKS:

1. **Mechanical Vibrations,** G. K.Grover, Nem Chand and Bros, 7th edition, 2003.
2. **Mechanical Vibrations,** S. S. Rao, Pearson Education Inc, 4th edition, 2003.
3. **Mechanical Vibrations,** V. P. Singh, DhanpatRai& Company, 3rd edition, 2006.

REFERENCE BOOKS:

1. **Theory of Vibration with Applications,** W. T. Thomson, M. D. Dahleh and C. Padmanabhan, Pearson Education Inc, 5th edition, 2008.
2. **Mechanical Vibrations:** S. Graham Kelly, Schaum's outline Series, Tata McGraw Hill, Special Indian Edition, 2007.
3. **Theory and Practice of Mechanical Vibrations:** J. S. Rao& K. Gupta, New Age International Publications, New Delhi, 2001.
4. **Vibration Fundamentals**, R. Keith Mobley, Newness, 1999.

SYLLABUS COVERAGE FOR CIE-1,2,3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (Firs100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each full question shall contain maximum of 2 subdivisions.

COURSE OUTCOMES: Learner will be able to

1.Define basic concepts of vibration of bodies having one, two and multi degree freedom Develop basic mathematical models and Estimate natural frequency of mechanical element/system for undamped and damped mechanical SDOF systems.

2. Discuss equations of motion Analyze vibratory response of mechanical element/system for free un damped and damped and forced vibration response and estimate the parameters of vibration isolation systems for industrial environment.

3.Ability to find vibration parameters numerically by 2-degree and multi degree freedom by various numerical techniques

4.Explore modern vibration measuring instruments. Condition monitoring of working machineries.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	2	2	3	3	2	3	3	1	2
CO2	2	3	3	2	2	1	3	2	3	3	3	2
CO3	3	3	3	2	3	2	3	1	3	2	3	2
CO4	3	3	2	2	3	2	3	1	2	2	3	3

- **High-3**
- **Medium-2**
- **Low-1**

ADMISSION YEAR : 2016-17 ACADEMIC YEAR : 2018-19
SEMESTER : SIXTH

COURSE TITLE : OPERATIONS RESEARCH		
Sub Code: ME64	**No of Credits : L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week : 04**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites		

COURSE OBJECTIVES:

1. Impart knowledge of mathematics, basic and applied sciences.
2. Ability to identify, formulate and solve mechanical engineering problems based on data interpretation, design, experiment and analysis of results.
3. Learn effective engineering communication.
4. Ability to work in teams on multi-disciplinary projects in industry and research organizations.
5. Develop awareness of the ethical, professional and environmental implications of work in a global and societal context.

#	CONTENTS	h
UNIT-1	**INTRODUCTION**	**08**
	Evolution of OR, definition of OR, scope of OR, application areas of OR, steps (phases) in OR study, characteristics and limitations of OR, models used in OR, linear programming (LP) problem-formulation and solution by graphical method. **SOLUTION OF LINEAR PROGRAMMING PROBLEMS**: The simplex method-canonical and standard form of an LP problem, slack, surplus and artificial variables.	
UNIT-2	**TRANSPORTATION PROBLEM**	**08**
	Formulation of transportation problem, types, initial basic feasible solution using different methods, optimal solution by MODI method, degeneracy in transportation problems, application of transportation problem, maximization cases.	
UNIT-3	**ASSIGNMENT PROBLEM**	**08**
	Assignment Problem-formulation balanced and unbalanced types, application to maximization cases and travelling salesman problem (Numericals).	
UNIT-4	**PERT-CPM TECHNIQUES**	**14**
	Introduction, network construction - rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects.	

UNIT-5	GAME THEORY	14
	Formulation of games, types, solution of games with saddle point, graphical method of solving mixed strategy games, dominance rule for solving mixed strategy games. **SEQUENCING:** Basic assumptions, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines. Sequencing 2 jobs on 'm' machines using graphical method. **REPLACEMENT:** Replacement items deteriorating with time, when money value remains same Replacement of items which fail suddenly; Individual replacement policy, Group replacement policy.	

TEXT BOOKS

1. **Operations Research,** P K Gupta and D S Hira, Chand Publications, New Delhi - 2007
2. **Operations Research,** Taha H A, Pearson Education

REFERENCE BOOKS

1. **Operations Research,** A P Verma, S K Kataria & Sons, 2008
2. **Operations Research,** Paneerselvan, PHI
3. **Operations Research,** A M Natarajan, P Balasubramani, Pearson Education, 2005
4. **Introduction to Operations Research,** Hiller and Liberman, McGraw Hill.

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each full question shall contain maximum of 2 subdivisions.

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Define models for linear programming
2. Convert the linear variable problems to a mathematical model and depict by graphical method.
3. Apply artificial variable technique to solve a linear programming model.
4. Compute the minimum cost of transportation by Modi's method and Hungarian method.
5. Design a project network diagram and schedule the project activities and duration.
6. Illustrate the strategies of different players in a game and find the best strategy by graphical and dominance method.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2016-17 ACADEMIC YEAR: 2018-19
SEMESTER : SIXTH

COURSE TITLE : INSPECTION AND QUALITY CONTROL		
Sub Code: ME651	**No of Credits : L-T-P-SS 3:0:0:0 =3**	**No. of lecture hours/week : 03**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Engineering Mathematics**	

COURSE OBJECTIVES:

1. The student should learn different inspection procedures, objectives in industry and economic aspects.
2. To impart definition of quality, components, concepts and different approaches followed like quality circles, cost of quality and economic considerations in quality.
3. To impart knowledge on various quality standards followed.
4. To impart fundamentals of statistical quality control charts, and process capability.
5. To impart different sampling techniques and reliability.

#	CONTENTS	h
UNIT-1	**INDUSTRIAL INSPECTION**	**05**
	Objectives and functions of inspection in industry, types of inspection, production/ inspection interaction, organization for industrial inspection, inspection procedures, economic aspect of inspection.	
UNIT-2	**CONCEPT OF QUALITY IN ENGINEERING**	**06**
	Meaning and significance of quality; essential components of quality; phases or elements for building quality; evolution of the concepts of quality; spiral of progress of quality; changing scope of quality activities. Total quality management (TQM) – definition, objectives, philosophy, and total productive maintenance (TPM) – definition, objectives, principles, implementation of TPM. Difference between TQM and TPM.	
UNIT-3	**QUALITY TOOLS & QUALITY MANAGEMENT SYSTEMS**	**06**
	QUALITY TOOLS: Ishikawa's seven quality tools; Quality Circles; Quality system economics, hidden quality costs; economic models of quality costs. **QUALITY MANAGEMENT SYSTEMS:** Introduction to various quality standards - ISO 9000, BIS.	
UNIT-4	**QUALITY CONTROL FUNCTION & CONTROL CHARTS**	**11**
	QUALITY CONTROL FUNCTION: Inspection versus quality control techniques, quality planning activities, organization for quality control. Fundamentals of statistical quality control, Juran's quality trilogy. **CONTROL CHARTS:** Charts for variables and attributes, application of control charts for averages, range, standard deviation, fraction defectives and number of non-	

	conformities per unit, process capability analysis and simple numerical problems.	
UNIT-5	**ACCEPTANCE SAMPLING & RELIABILITY**	**11**
	ACCEPTANCE SAMPLING: Elementary concepts, sampling by attributes, single, double and multiple sampling plans, construction and use of operating characteristic curves and simple problems. **RELIABILITY:** Reliability engineering, rectification processes in industries, practical activity – quality report building, reliability function, failure rate, mean time between failures (MTBF), mean time to failure (MTTF), mortality curve, useful life availability, maintainability, system effectiveness and simple numerical problems on RELIABILITY, MTBF and MTTF.	

TEXT BOOKS

1. Juran, J. M. and Gryna, F. M., Quality Planning & Analysis, Tata McGraw Hill, New Delhi (1995).
2. Grant, E. L., Statistical Quality Control, McGraw Hill International, New York (2005).
3. Charles E Ebling, An introduction to reliability and maintainability engineering, Tata McGraw-Hill Education, 2004 - Maintainability (Engineering).

REFERENCE BOOKS

1. Feignbaum, A. V., Total Quality Control, McGraw Hill International, New York (1991).
2. Besterfield, D.H., Total Quality Management, Pearson Education Asia, New Delhi (2003)

<u>SYLLABUS COVERAGE FOR CIE-1,2,3</u>
CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (Firs100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each full question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES:

1. The student will have the knowledge of inspection activity and functions that are followed in industry.
2. The student can carry out different quality procedures using different quality tools like quality circles, determine quality costs.
3. Understand various quality systems prevalent in industry.
4. The student is in a position to construct various control charts based on data available in an industrial production, can also dwell upon the status of a process whether in control or out of control and find number of defectives.
5. The student can carry out sampling, reliability techniques with an industrial application.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2016-17 **ACADEMIC YEAR: 2018-19**
SEMESTER : SIXTH

COURSE TITLE : PRODUCT DESIGN & MANUFACTUROING		
Sub Code: ME652	**No of Credits : L-T-P-SS 3:0:0:0 =3**	**No. of lecture hours/week : 03**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Manufacturing process**	

COURSE OBJECTIVES:

1. Impart knowledge of mathematics, basic and applied sciences.
2. Ability to identify, formulate and solve mechanical engineering problems based on data interpretation, design, experiment and analysis of results.
3. Learn effective engineering communication.
4. Ability to work in teams on multi-disciplinary projects in industry and research organizations.
5. Develop awareness of the ethical, professional and environmental implications of work in a global and societal context.
6. Ability to self-learn modern engineering tools, techniques, skills and contemporary engineering practice, necessary for engineering work.

	CONTENTS	hr
UNIT-1	**STAGES IN DESIGN PROCESS**	**5**
	Introduction to various stages of the design process: Formulation of problem, Generation of alternatives, Evaluation, Guided Redesign, Case study. **PRODUCT LIFE CYCLE:** New product introduction: early introduction, increased product life. Life cycle management tools: System integration, QFD, House of quality, Pugh;s method, Pahl and Beitz method. Case studies.	
UNIT-2	**VALUE ENGINEERING**	**5**
	Introduction, nature and measurement of value. Value analysis job, plan creativity and techniques of creativity. Value analysis test, case studies. **CONCURRENT/ REVERSE ENGINEERING** Introduction, basic principles, components, benefits of concurrent engineering. Concept of reverse engineering.	
UNIT-3	**MATERIAL SELECTION**	**7**
	Materials in design. Evolution of engineering materials. Design tools and material data. Function, material, shape and process. 3D printing, attribute limits, selection process, computer aided material selection. Case studies **PROCESS SELECTION** Introduction. Process classification: shaping, joining and finishing. Systematic process	

	selection. Ranking, process cost. Computer aided process selection.	
UNIT-4	**DESIGN FOR MANUFACTURE AND ASSEMBLY**	**11**
	Introduction: Design for Manufacture and Assembly (DFMA), Reasons for not implementing DFMA Advantages of DFMA with case studies. Design features and requirements with regard to assembly, production. Design for Manufacture in relation to any two manufacturing processes: machining and injection moulding, Need, objectives.	
UNIT-5	**PRODUCT DESIGN PRACTICE & INDUSTRY**	**11**
	Introduction, product strategies, time to market ,analysis of the product, the Product characteristics, the Three S's, Standardization, Simplification, the designer and his role, the industrial design organization, design considerations , problems faced by industrial designer, procedure adopted by industrial designers, types of models designed by industrial designers, role of aesthetics in product design, functional design practice.	

Text books:

1. A K Chitale and R C Gupta, Product Design & Manufacturing, PHI

References:

1. Kevin Otto, Kristin Wood, Product Design, pearsonEducationj in South Asia.
2. Timjones, Butterworth Heinmann, New Product Development, Oxford, UCI, 1997.
3. Geoffery Boothoyd, peter Dewhurst and Winston Knight, Product Design for Manufacture
4. John M. Usher, Utpal Roy and H. R. Parasaei Integrated Product and Process Development Tata McGraw Hill

<u>SYLLABUS COVERAGE FOR CIE-1,2,3</u>
CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (Firs100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each full question shall contain maximum of 2 subdivisions.

COURSE OUTCOMES: On completion of the course, student should be able to;

1. To apply knowledge of mathematics, science, and engineering design and conduct experiments, as well as to analyse and interpret data.
2. Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
3. Function on multidisciplinary teams identify, formulate and solve engineering problems. To understand professional and ethical responsibility. Communicate effectively.
4. Understand the impact of engineering solutions in a global, economic, environmental, and societal context.
5. Recognize the need to engage in life-long learning attain knowledge of contemporary issues use the techniques, skills, and modern engineering tools necessary for engineering practice.

ADMISSION YEAR : 2016-17 **ACADEMIC YEAR: 2018-19**
SEMESTER : SIXTH

COURSE TITLE : AUTOMOTIVE ENGINEERING (CORE ELECTIVE)		
Sub Code: ME653	**No of Credits : L-T-P-SS 3:0:0:0 =3**	**No. of lecture hours/week : 03**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	Elements of Mechanical Engineering, Basic and Applied Thermodynamics	

COURSE OBJECTIVES:

1. To describe the basic systems and components of Automobiles and to analyze Engines, other power generation modes and its allied mechanisms.
2. To emphasize on Fuel characteristics and Fuel flow systems and to explain combustion phenomena and ignition systems.
3. To demonstrate Power transmission mechanisms, Steering mechanisms, Suspension systems and braking systems.
4. To define super charging and Turbo charging, explain the body constructional details, different methods of controlling emission in automobiles and discuss different emission standards.

Unit	CONTENTS	Hours
UNIT-1	**ENGINE COMPONENTS, COOLING & LUBRICATION SYSTEMS**	08
	Spark Ignition (SI) & compression Ignition (CI) engines, cylinder arrangements and their relative merits, liners, piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve and port timing diagrams, types of combustion chambers for S.I. engine and C. I. engines, compression ratio, methods of a swirl generation, choice of materials for different engine components, engine positioning, cooling requirements, methods of cooling, thermostat valves, different lubrication arrangements. **Fuels, Fuel Supply Systems For SI And CI Engines** Conventional fuels, alternative fuels, normal and abnormal combustion, cetane and octane numbers.	
UNIT-2	**DRIVE TO WHEELS**	06
	Propeller shaft and universal joints, Hotchkiss and torque tube drives, differential, rear axle, different arrangements of fixing the wheels to rear axle, steering geometry, camber, king pin inclination, included angle, castor, toe in & toe out, condition for exact steering, steering gears, power steering, general arrangements of links and stub axle, over steer, under steer and neutral steer, numerical problems, types of chassis frames. **Suspension springs** Requirements, Torsion bar suspension systems, leaf spring, coil spring, independent	

	suspension for front wheel and rear wheel. Air suspension system.	
UNIT-3	**BRAKES AND AUTOMOTIVE EMISSION CONTROL SYSTEMS**	05
	Brakes Types of brakes, mechanical compressed air, vacuum and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes, drum brakes, antilock braking systems, purpose and operation of antilock-braking system, ABS hydraulic unit, rear-wheel antilock & Numerical problems. **Automotive emission control systems** Automotive emission controls, controlling crankcase emissions, controlling evaporative emissions, cleaning the exhaust gas, controlling the air-fuel mixture, controlling the combustion recirculation, treating the exhaust gas, air-injection system, air-aspirator system, catalytic converter, emission standards- euro and bharat norms.	
UNIT-4	**FUEL MIXTURE REQUIREMENTS FOR SI ENGINE**	**10**
	Types of carburetors, C.D. & C.C. carburetors, single point and multi point fuel injection systems, fuel transfer pumps, Fuel filters, fuel injection pumps and injectors. **Superchargers and turbochargers** Naturally aspirated engines, forced induction, types of superchargers, turbocharger construction and operation, intercooler, turbocharger lag.	
UNIT-5	**IGNITION SYSTEMS, POWER TRAINS and GEAR BOX**	**10**
	Ignition Systems Battery ignition systems, magneto Ignition system, transistor assist contacts. Electronic ignition, automatic ignition advance systems. **Power trains** General arrangement of clutch, principle of friction clutches, torque transmitted, constructional details, fluid flywheel, single plate, multi-plate and centrifugal clutches. **Gear box** Necessity for gear ratios in transmission, synchromesh gear boxes, 3, 4 and 5 speed gear boxes. Free-wheeling mechanism, planetary gears systems, over drives, fluid coupling and torque converters, epicyclic gear box, principle of automatic transmission, calculation of gear ratios, Numerical calculations for torque transmission by clutches.	

TEXT BOOKS

1. **Automotive mechanics,** William H Crouse & Donald L Anglin, 10th Ed. TMH 2007
2. **Automobile Engineering**, Vol I and II, Kirpal Singh, 2002.

REFERENCE BOOKS:

1. **Automotive mechanics: Principles and Practices**, Joseph Heitner, D Van Nostrand Company, Inc
2. **Fundamentals of Automobile Engineering,**K.K.Ramalingam, Scitech Publications (India) Pvt. Ltd.
3. **Automobile Engineering**, R. B. Gupta, Satya Prakashan, 4th edn. 1984.

QUESTION PAPER PATTERN (SEE)

<table>
<tr><td>Q. No.</td><td>Q1</td><td>Q2</td><td>Q3</td><td>Q4</td><td>Q5</td><td>Q6</td><td>Q7</td></tr>
<tr><td>UNIT</td><td>1</td><td>2</td><td>3</td><td colspan="2">4</td><td colspan="2">5</td></tr>
</table>

SCHEME OF EXAMINATION (Question Paper Pattern)

1. Seven Full Questions to be set and Five full Questions to be answered.
2. Unit-1, Unit-2 and Unit-3 are compulsory, with one question from each Unit and from Unit-4 and Unit-5: Two questions to be set with choice

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Distinguish the types of fuels used in I C engines and categorise the types of transmissions and suspension systems used in modern automobiles.
2. Understand various sensors and actuators to actuate safety devices in automobiles.
3. Work on the design of combustion chambers.
4. Build the basic starter and generator devices.
5. Understand the working of Anti-lock braking systems and GPS systems
6. Compare the various emission control systems.

MAPPING OF COs WITH POs

COs/POs	**A**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**L**
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2016-17 **ACADEMIC YEAR: 2018-19**
SEMESTER : SIXTH

COURSE TITLE : INDUSTRIAL MANAGEMENT		
Sub Code: ME661	**No of Credits : L-T-P-SS 3:0:0:0 =3**	**No. of lecture hours/week : 03**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites		

COURSE OBJECTIVES:

1. Discuss the development of management thought
2. Evaluate the human behavior concepts and HRM.
3. Analyze the economic relations for managerial analysis and marketing
4. Understand the concept of plant management, motivation, leadership.
5. Understand the concept of productivity.
6. Understand the concept of materials management.

#	CONTENTS	Hrs
UNIT-1	**BASICS OF MANAGEMENT:** Principles of management, Concepts of management, development of scientific management, principles of Fredric W. Taylor, principles of Henry Fayol & functions such as planning, organizing, staffing, leading, motivating, communicating, controlling, decision making, span of control, delegation of authority.	**05**
UNIT-2	**MOTIVATION & LEADERSHIP:** Factors determining motivation, Characteristics of motivation. Methods for improving motivation. Maslow and Herzberg theory, incentives, pay, promotion, rewards. Job satisfaction and job enrichment. Need for leadership. Functions of a leader. Factors for accomplishing effective leadership. Manager as a leader.	**05**
UNIT-3	**PERSONNEL MANAGEMENT:** Meaning, functions of personnel management, manpower planning, selection, arbitration, collective bargaining, wages & salary administration, labor welfare, training, trade unions, Trade union act & Labor Legislation.	**06**
UNIT-4	**PLANT MANAGEMENT:** Plant location, plant layout, Material handling objectives, principles & selection of material handling equipment's types. Industrial safety, causes & cost of accidents, accident biorhythms, safety programs, job, batch & process type of production. **PRODUCTIVITY:** Definition of productivity, individual enterprises, task of management Productivity of materials, land, building, machine and power. Measurement of productivity, factors affecting the productivity, productivity improvement programs, wages and incentives (Simple Numerical problems).	**11**

UNIT-5	**MARKETING MANAGEMENT:** Definition, selling & modern concept of marketing, market research, marketing mix, new product development, product life cycle, new product launching, sales promotion, pricing, channels of distribution, advertising, market segmentation. **MATERIALS MANAGEMENT:** Material in industry, inventory control model, ABC Analysis, Safety stock, Reorder, level, Economic ordering quantity, Stores equipment, Stores records, purchasing procedures, purchase records, Bin card, Cardex. [Simple Numerical problems].	**12**

TEXT BOOKS:

1. Industrial Engineering and Management by TR Banga.
2. Industrial Engineering and Management by OP Khanna Dhanpat Rai Publications, Delhi.

REFERENCE BOOKS:

3. Principles of Management by Philip Kotler, TEE Publication.
4. Industrial Management by VK Sharma, OP Harkut.

REMINDER:

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)
(Irrespective of portions covered due to whatever might be the reason)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.

COURSE OUTCOMES:

1. Discuss the development of management thought
2. Evaluate the human behavior concepts and HRM.
3. Analyze the economic relations for managerial analysis and marketing
4. Understand the concept of plant management, motivation, leadership.
5. Understand the concept of productivity.
6. Understand the concept of materials management.

ADMISSION YEAR : 2016-17 ACADEMIC YEAR: 2018-19
SEMESTER : SIXTH

COURSE TITLE : ADVANCED WELDING PROCESSES		
Sub Code: ME662	**No of Credits : L-T-P-SS 3:0:0:0 =3**	**No. of lecture hours/week : 03**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Manufacturing process**	

1. To understand the working principle, advantages, disadvantages of elctroslag, electrogas welding, thermit welding.
2. The student gains information on different solid-state welding processes.
3. To understand the working principle, weld characteristics and process parameters of high energy beam welding.
4. To understand the process of thermal cutting of materials, brazing and soldering.
5. To understand the concept about underwater welding, welding in space and welding metallurgy.

#	CONTENTS	Hrs.
UNIT 1	**FUSION WELDING PROCESSES**	**06**
	Classification of welding processes, energy sources used in welding, working principle, process variables, advantages, limitations and applications of electro slag, electro gas. Thermit welding -working principle, thermit mixtures and applications.	
UNIT 2	**SOLID STATE WELDING PROCESSES**	**06**
	Friction welding, types, friction stir welding, tools used in FSW, ultrasonic welding, adhesive bonding, diffusion bonding, explosion welding- working principle, process variables, process characteristics, advantages, limitations and applications	
UNIT 3	**ENERGY BEAM WELDING PROCESSES**	**05**
	Electron beam and Laser beam welding-working principle, equipment details, process characteristics, process variables, advantages, limitations and applications.	
UNIT 4	**BRAZING, SOLDERING AND THERMAL CUTTING**	**11**
	Introduction, brazing, soldering, various techniques, their advantages, limitations and applications; brazing & soldering consumables. Oxy- Acetylene cutting-working principle, metal powder cutting, introduction to oxygen/air / plasma / metal arc cutting arc cutting and gouging; advantages, limitations and	

	applications of various techniques	
UNIT 5	**UNDERWATER WELDING, WELDING IN SPACE AND WELDING METALLURGY**	**11**
	Introduction to wet and dry under water welding & cutting Introduction, welding techniques, difficulties and advantages of welding in space. Welding metallurgy: Introduction, weldability of carbon steel, stainless steel & aluminum. Hot & cold cracking phenomenon, weld defects, causes and their remedies	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Differentiate the mechanism, working principle and process characteristics of electroslag, electro gas welding and thermit welding.
2. know the working principle, process characteristics, of friction welding, friction stir welding, ultrasonic welding, adhesive boning, explosion welding and diffusion bonding.
3. Describe the mechanism, working principle and process characteristics of high energy beam welding.
4. Differentiate between **s**oldering and brazing, their techniques, advantages and limitations, applications. And also decide best cutting techniques for a particular application and their limitations.
5. Describe working principle and process characteristics of underwater welding processes, welding in space. And weldability of carbon steel, stainless steel & aluminum. Hot & cold cracking phenomenon, weld defects, causes and their remedies.

TEXT BOOKS:

1. S.V.Nadkarni, "Modern Arc Welding Technology", Oxford & IBH.
2. R.Little, "Welding Technology, TMH. WELDING CODES AND STANDARDS
   ME-9111 L T P.
3. Welding metallurgy by Sindo Kou, Welding metallurgy, 2nd Edition Nov. 2002, Wiley

REFERENCE BOOKS:

1. H.B.Cary, "Modern Arc Welding Technology", Englewood Cliffs, Prentice Hall.
2. Leonard P Connor, Welding Hand book, Volume I-III, AWS.
3. Metals Hand book, Volume 6, American Society of Metals.
4. Dave Smith, "Welding skills and technology", McGraw Hill.

REMINDER:

BREAK-UP OF COURSE CONTENTS FOR;

1. CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
2. CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
3. CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

(Irrespective of portions covered due to whatever might be the reason)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each full question shall contain maximum of 3 subdivisions.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	2	3	1	2	1	1	1	1	1	1	0
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2016-17 ACADEMIC YEAR: 2018-19
SEMESTER : SIXTH

COURSE TITLE : ADVANCED HEAT TRANSFER (CORE ELECTIVE)		
Sub Code: ME663	**No of Credits : L-T-P-SS 3:0:0:0 =3**	**No. of lecture hours/week : 03**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Basic & Applied Thermodynamics, Fluid Mechanics, Heat Transfer**	

COURSE OBJECTIVES:

1. To understand the heat conduction in solids with variable thermal conductivity and heat generation.
2. To solve steady and unsteady heat conduction problems using finite difference method.
3. To derive the differential equation of heat convection and solve problems related to flow over solids of different geometry.
4. To understand the heat transfer by natural convection and analyse the correlations for enclosed spaces to solve numerical problems.
5. To explain the phenomena of condensation and boiling and understand the correlations related to them.
6. To understand the mass transfer and different types of mass transfer.

#	CONTENTS	h
UNIT-1	**HEAT CONDUCTION IN SOLIDS**	**07**
	The differential equation of heat conduction, Variable thermal conductivity, Heat generation, Two-dimensional steady state heat conduction, Unsteady state heat conduction processes, The finite difference method for solving steady and unsteady state heat conduction problems, Related numerical problems.	
UNIT-2	**HEAT TRANSFER BY FORCED CONVECTION**	**06**
	The differential equation of heat convection, Laminar and turbulent flow heat transfer in a pipe, The thermal boundary layer, Heat transfer in laminar flow over a flat plate, The integral method, Analogy between heat and momentum transfer, Heat transfer in turbulent flow over a flat plate, Flow across a cylinder, Flow across banks of tubes, Related numerical problems.	
UNIT-3	**HEAT TRANSFER BY NATURAL CONVECTION**	**06**
	Introduction, Natural convection heat transfer from a vertical plate, Correlations for a horizontal cylinder and a horizontal plate, Correlations for enclosed spaces, Combined convection, Related numerical problems.	
UNIT-4	**CONDENSATION AND BOILING**	**10**
	Introduction, Film and drop condensation, Film condensation on a vertical plate, Condensation on horizontal tubes, Effect of superheated vapour and of non-condensable gases, Type of boiling, Correlations in saturated pool boiling, Flow boiling, Related numerical problems.	
UNIT-5	**MASS TRANSFER**	**10**
	Introduction, Fick's law of diffusion, Steady state mass diffusion in a stationary medium, Diffusion in mixing medium, Convective mass transfer, Analogy between heat and mass transfer, Simultaneous heat and mass transfer, Related numerical problems.	

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TEXT BOOKS

1. **A Text Book on Heat Transfer,** S.P. Sukhatme, 4thEdition, Universities Press, 2005.
2. **Heat and Mass Transfer,** P.K. Nag, 3rd Edition, Tata McGraw-Hill Publications, 2011.
3. **A Course in Heat and Mass Transfer,** Domkundwar, Arora, Domkundwar, DhanpatRai Publications, 2005.

REFERENCE BOOKS

1. **Heat and Mass Transfer**, Cengel,Y.A., and Ghajar, A.J., 4th Edition, McGraw-Hill Publications, 2011.
2. **Principles of Heat and Mass Transfer**, Frank P. Incropera, David P. Dewitt, Theodore L. Bergman, and Adrienne S. Lavine, 7th Edition, Wiley Student Edition, 2013.

e-LEARNING RESOURCES

1. **A Heat Transfer Text Book**, John H Leinard IV and John H Leinard V, 3rd Edition, Phlogiston Press, Cambridge, Massachusetts, USA, 2008.
2. **Heat and Mass Transfer: Mechanical Engineering Handbook**, Kreith, F., Boehm, R.F., et. al., Frank Kreith (Ed), Boca Raton: CRC Press LLC, 1999.
3. **Fundamentals of Heat and Mass Transfer**, Frank P. Incropera, David P. Dewitt, et. al. Frank P. Incropera (Ed), 6th Edition, John Wiley and Sons, 2007.
4. **e-Journal: Frontiers in Heat and Mass Transfer**, http://www.ThermalFluidsCentral.org
5. **Videos, Student slides, Handouts, Lecture notes:** http://www.nptel.ac.in

DATA HAND BOOK AND CHARTS

1. **Heat and Mass Transfer Data Hand Book,** C.P. Kothandaraman, S. Subramanyan, New Age International Publishers, 8th Edition, 2014.
2. **Steam Tables with Mollier Diagram: SI Units**, Mahesh M.Rathore, DhanpatRai Publishing Company, 2014.

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each full question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES: On completion of the course, student should be able to;

1: Describe conduction and convection heat transfer mechanisms, boiling, condensation and mass transfer.

2: Distinguish the heat and mass transfer modes with examples and illustrations.

3: Sketch and solve problems related to application of conduction, convection, boiling, condensation and mass transfer.

4: Compare and analyse different modes of heat transfer.

5: Derive mathematical expressions and equations to determine the heat and mass transfer rate.

6: Calculate the rate of heat and mass transfer and compute the performance of various heat and mass transfer systems.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	2	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2016-17 **ACADEMIC YEAR: 2018-19**
SEMESTER : SIXTH

COURSE TITLE : DESIGN LABORATORY		
Sub Code: MEL67	**No of Credits : L-T-P-SS 0:0:2:0 = 1**	**No. of lecture hours/week : 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 50**
Pre-requisites	**Design of machine elements**	

COURSE OBJECTIVES:

1. The main objective of this lab is to expose the student of mechanical engineering to various experimental techniques in order to prepare them for their professional career (Industrial and or R&D). The equipment's / instrumentation proposed are expected to provide the students a lot of insight into various experimental techniques in general and those connected with major mechanical systems in particular.
2. The experiment sequence is arranged in such a way to facilitate to introduce the students to engineering fundamentals, to develop their abilities to design experiments, and to motivate them to learn computer applications for data analysis.

#	CONTENTS	h
UNIT-1	1. Experimental prediction of natural frequency of compound pendulum, prediction of equivalent simple pendulum system. 2. Experimental prediction of natural frequency for longitudinal vibrations of helical springs, and springs in series and parallel with or without damping 3. Experimental prediction of natural frequencies, and nodal points for single rotor and two-rotor vibratory system, and comparison with theoretical results 4. Experimental and theoretical investigation of whirling of shaft (i.e. . comparison of experimental and theoretical natural frequency and justification of discrepancy between experiment and theory) 5.Determination of Fringe constant of Photo elastic material using (a) Circular disc subjected to diametric compression (b) Pure bending specimen (four point bending).(c) Tensile specimen. 6.Determination of stress concentration using Photo elasticity for simple components like circular disk with circular hole under diametrical compression, plate with a hole under tension or bending, 2D Crane hook.	**18**
UNIT-2	1. Determination of centrifugal force, power, effort, range speed sensitiveness of Porter/ Watt /Hartnel Governor. (Only one or more). 2. Determination of Principal Stresses and strains young's modulus in a member to tensile/combined loading using Strain rosettes. 3. Experiments on Gyroscope.	**08**

QUESTION PAPER PATTERN (SEE)

UNIT	1	2
Q. No.	Q1	Q2

SCHEME OF EXAMINATION (SEE)

Sl. No.	Particulars	Max. Marks	Break Up of Max. Marks		
			Write Up	Conduction of experiment	Specimen Calculation, Tabulation of Results and Plotting of Graph if any
1	**Unit-1: Minor Experiment** (Any ONE from the list of experiments and it is purely individual Experiment) Q1	**15**	05	05	05
2	**Unit-2: Major Experiment** (Any ONE **Experiment** from the list of experiments and it is a Group Experiment) Q2	**25**	05	10	10
3	Viva Voce	**10**	--	--	--
	TOTAL MARKS	**50**	**10**	**25**	**15**

- Two Full Questions to be set.
- Students shall be to be answered two full Questions.
- Each question(Experiments contains different Marks and it is clearly mentioned in the above table)
- Changing of Experiments is not allowed from any unite if changing of experiments allowed 50% marks will be deducted.
- Viva Voce is compulsory

REFERENCES TEXT BOOKS :

1. **Advanced Mechanics of solids**, L. S. Srinath, Tata Mc. Graw Hill, 2003
2. **Theory of Elasticity,** S. P. Timoshenko and J. N Gordier, Mc.Graw Hill International, 3rd edition, 1972
3. **Theory of Elasticity,** Dr. Sadhu Singh, Khanna Publications, 1988
4. **Elasticity, Theory, Applications &Numericals,** Martin H Sadd, Elsevier. 2005
4. **Applied Elasticity,** Seetharamu & Govindaraju, Interline Publishing

COURSE OUTCOMES:

The major impact of the state of the art machine design lab is the exposure the students get to the modern experimental techniques and instrumentation. The experiments are planned in such a way that by the end of the course, the student is expected to have enough potential to design the experimentation as required at that point of time.

1.The major impact of the state of the art machine design lab is the exposure the students get to the modern experimental techniques and instrumentation.
2.Students will be able to understand the essence of kinetics and dynamics through experiments.
3. Students will be able to visualize the stresses developed in an object through photo elasticity implementation of concept of stress concentration in design.
4 The experiments are planned in such a way that by the end of the course, and the student has potential to design the experimentation as required at that point of time.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	2	2	3	3	2	3	3	1	2
CO2	2	3	3	2	2	1	3	2	3	3	3	2
CO3	3	3	3	2	3	2	3	1	3	2	3	2
CO4	3	3	2	2	3	2	3	1	2	2	3	3

- **High-3**
- **Medium-2**
- **Low-1**

ADMISSION YEAR : 2016-17 **ACADEMIC YEAR: 2018-19**
SEMESTER : SIXTH

COURSE TITLE : COMPUTER INTEGRATED MANUFACTURING LABORATORY		
Sub Code: MEL68	**No of Credits : L-T-P-SS 0:0:2:0 = 1**	**No. of lecture hours/week : 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 50**
Pre-requisites	**CAD/CAM**	

COURSE OBJECTIVES:

1. Computer based numerically controlled machine tools are increasingly finding place in industries.
2. Further integration of the computer Aided Design Drafting (CADD), which has been in use in the industry for some years now, with (CAM) Operations has led to efficient product design & prototyping and shorter production runs.
3. The need to absorb, CAD/ CAM technology for its effectives has, therefore, become imperative.
4. This course is being introduced as Practical course of BE programme in mechanical engineering.
5. The course aims at developing appreciation of the use of CAD/CAM environment, its Components, their functions, and methods of using the existing CAD/ CAM software, in general, with a view to improve efficiency in drafting and designing.

#	**CONTENTS**	**Hrs**
PART A	➢ CNC part programming using CAM packages. ➢ Simulation of Turning, Drilling, Milling operations. ➢ Three typical simulations to be carried out using simulation packages like Master-CAM, or any equivalent software.	**18**
PART B	**ONLY FOR DEMO/VIVA VOCE)**	**04**
	➢ FMS (Flexible Manufacturing System): Programming of Automatic storage and Retrieval system (ASRS) and linear shuttle conveyor Interfacing CNC lathe, milling with loading unloading arm and ASRS to be carried out on simple components. ➢ Robot programming: Using Teach Pendent & Offline programming to perform pick and place, stacking of objects, 2 programs.	
PART C	**(ONLY FOR DEMO/VIVA VOCE)**	**04**
	➢ Pneumatics and Hydraulics, Electro-Pneumatics: Three typical experiments on Basics of these topics to be conducted.	

COURSE OUTCOMES:

1. At the end of the COURSE, he must be in a position to giving the solutions by his depth of the COURSE knowledge to perform any machining operation with maximum accuracy as per the required standard by CNC easily.
2. This will enhance to improve the large production with zero rejection of industries.
3. Thus industrial peoples can able to fulfill the customer requirements.

SCHEME OF EXAMINATION

Two questions from Unit 1(Milling and turning) – 40 Marks (10 Write up +30)

Viva Voce – 10 Marks

Total – 50 Marks

ADMISSION YEAR : 2016-17 ACADEMIC YEAR: 2018-19
SEMESTER : SIXTH

COURSE TITLE : MINI - PROJECT WORK		
Sub Code: MEL69	**No of Credits : L-T-P-SS 0:0:4:0 = 2**	**No. of lecture hours/week : 04**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 50**

COURSE OBJECTIVES:
1. To instill an atmosphere in students to find a working situation and discover the workable area.
2. To insure a transition from planned laboratory course to planning one independently.

#	CONTENTS	
PART A	**FABRICATION**	
	Simple fabrication related to mechanical projects on a mini scale	
PART B	**MODELING & ANALYSIS**	
	Projects using Modeling and analysis tools project related to realistic problems of mechanical stream	

COURSE OUTCOMES: On completion of the course, student should be able to;
1. Literature review on national journal standards and define the problem.
2. Design Experiments scientifically / Perform Numerical Analysis / Develop Analytical models to Interpret the Results and Prepare quality document

SCHEME OF VALUATION:
Departments shall constitute a Departmental Project Review Committee (faculty+guide)
Project evaluation shall be done by the departmental committee along with the guide and the marks shall be submitted to exam section.
CIE-1: project evaluation in the middle of the semester for 25 marks. CIE-2: project evaluation at the end of the semester for 25 marks.
SEE: evaluation by both internal and external examiners for 50 marks by conducting project viva-voce.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	1	2	1	1	1	1	2	1	1
CO2	3	3	2	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2017-18 ACADEMIC YEAR: 2018-19
SEMESTER : THIRD

COURSE TITLE : FLUID MECHANICS		
Sub Code: ME31	**No of Credits : L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week : 04**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Physics, Mathematics**	

COURSE OBJECTIVES:

1. Explain various properties related to fluid mechanics.
2. Determine hydrostatic force and centre of pressure on plane and curved surfaces, locate met centre and Meta centric height of floating bodies.
3. Summarize different types of pressure measurement devices.
4. Apply laws of conservation of momentum, mass and energy to fluid flow systems and explain the measurement of fluid flow parameters.
5. Interpret compressibility of gases in terms of Mach number.

#	CONTENTS	h
UNIT-1	**PROPERTIES OF FLUID**	**10**
	Introduction, classification of fluids, properties of fluids, viscosity, thermodynamic properties, surface tension, capillarity, vapour pressure, cavitation phenomenon. Numerical problems. **Fluid statics:** Fluid pressure at a point, Pascal's law, pressure variation in a static fluid, absolute, gauge, atmospheric and vacuum pressures, simple manometers and differential manometers. Numerical problems.	
UNIT-2	**SUBMERGED BODIES AND BUOYANCY**	**08**
	Submerged bodies: Total pressure and center of pressure on submerged plane surfaces; horizontal, vertical and inclined plane surfaces, curved surface submerged in liquid. Related numerical problems. **Buoyancy:** Buoyancy, center of buoyancy, met centre and met centric height, conditions of equilibrium of floating and submerged bodies, determination of metacentric height experimentally and theoretically. Numerical problems.	
UNIT-3	**FLUID KINEMATICS AND DYNAMICS**	**08**
	Fluidkinematics: Types of fluid flow, continuity equation in 2Dand 3D (Cartesian Co-ordinates only), velocity and acceleration, Numerical problems. **Fluid dynamics:** Introduction, Equation of motion, Euler's equation of motion, Bernoulli's equation from first principles and also from Euler's equation, limitations of Bernoulli's equation. Numerical problems.	
UNIT-4	**FLUID FLOW MEASUREMENTS ANDFLOW THROUGH PIPES**	**13**
	Fluid flow measurements: Applications of Bernoulli's equation, venturimeter, orifice meter, pitot-tube, vertical orifice, V-notch and rectangular notches, Numerical problems. Navier-stoke's Equation. **Flow through pipes:** Introduction, major and minor losses through pipes. Darcy's and Chezy'sequation for loss of head due to friction in pipes.HGL and TEL. Numerical problems. **Laminar flow and viscous effects:** Reynold's number, critical Reynold's number, laminar flow through circular pipe-Hagen Poiseille's equation, laminar flow between parallel and stationary plates. Numerical problems.	
UNIT-5	**FLOW PAST IMMERSED BODIES AND COMPRESSIBLE FLOW**	**13**

	Flow past immersed bodies: Introduction, drag, lift, expression for lift and drag, boundary layer concept, displacement, momentum and energy thickness. Numerical problems. **Compressible flow:** introduction – stagnation properties relationship, velocity of sound in a fluid, mach number, mach cone, propagation of pressure waves in a compressible fluid. Numerical problems.	

TEXT BOOKS

1. **A Textbook of Fluid Mechanics and Hydraulic Machines (SI Units)**, Dr. R.K. Bansal, Laxmi Publications (P) Limited, Revised 9th Edition,, 2010.
2. **Hydraulics and Fluid Mechanics including Hydraulic Machines**, Dr. P.N. Modi and S.M. Seth, Rajsons Publications Private Limited, Standard Book House, 2009.

REFERENCE BOOKS

1. **Fluid Mechanics: Fundamentals and Applications (SI Units),**Yunus A. Cengel, JohnM.Cimbala. McGraw-Hill Publications (SIE), 3rd Edition, 2014.
2. **Fluid Mechanics**, Frank M. White, McGraw-Hill Publications (SIE), 7th Edition, 2011.

e-LEARNING RESOURCES

1. **Fluid Mechanics: Mechanical Engineering Handbook,** Kreith,F, Berger, S.A, et. al., Ed. Frank Kreith, Boca Raton: CRC Press LLC, 1999.
2. **Videos and Lecture Notes:** http://www.nptel.ac.in

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each full question shall contain maximum of 3 subdivisions.

COURSE OUTCOME (CO)

After completion of the course, students will be able to:

1: Define and describe fluid properties, define buoyancy and related laws, list the types of fluid flow and flow measuring devices and describe concept of boundary layer.

2: Illustrate the laws of fluid mechanics with suitable examples; explain the different types of manometers and distinguish various equations of motion.

3: Apply the various equations and solve numerical problems related to fluid statics, kinematics and dynamics, laminar and viscous effects and compressible flow.

4: Compare the different types of flow measuring devices, classify flow types.

5: Derive the equations of motion and other flow related equations, and develop various mathematical relations relevant to various flow regimes.

6: Calculate the various parameters for the given numerical problems.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	1	1	1
2	3	3	2	1	2	1	1	1	1	2	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	3	1	1	1	1	2	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2017-18 ACADEMIC YEAR: 2018-19
SEMESTER : THIRD

COURSE TITLE : BASIC THERMODYNAMICS		
Sub Code: ME32	**No of Credits : L-T-P-SS 4:0:0:0= 4**	**No. of lecture hours/week : 04**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Engineering physics, engineering mathematics**	

COURSE OBJECTIVES:

1. To understand the fundamental concepts of thermodynamic system, process and cycle.
2. To explain work and heat transfer with illustrations and examples.
3. To interpret first and second law of thermodynamics in the context of closed and open system.
4. To understand the concept of entropy and the principle of increase of entropy.
5. To solve problems related to thermodynamic system applying the various thermodynamic relations to pure substances and gases.

#	**CONTENTS**	**h**
UNIT-1	**FUNDAMENTAL CONCEPTS**	**08**
	Macroscopic and microscopic viewpoint, thermodynamic system and control volume, thermodynamic property, process and cycle, homogeneous and heterogeneous system, thermodynamic equilibrium, quasi-static process, pure substance, concept of continuum, thermostatics, units and dimensions; zeroth law of thermodynamics. Work transfer, pdV work – path function and point function, pdV work in various quasi-static processes, indicator diagram, other types of work transfer, free expansion with zero work transfer, net work done by a system, heat transfer, heat transfer as a path function, specific heat and latent heat, comparison of heat and work transfer, numericals.	
UNIT-2	**FIRST LAW OF THERMODYNAMICS**	**09**
	First law of a closed system undergoing a cycle (Joule's experiment) and undergoing a change of state, energy as a property of a system, forms of stored energy, specific heat at constatn volume and constant pressure, enthalpy, energy of an isolated system, PMM 1, limitations of the first law; application of first law to flow processes – control volume, steady flow process, mass and energy balance in a simple steady flow process, examples of steady flow processes -turbines, pumps, nozzles and diffusers.	
UNIT-3	**SECOND LAW OF THERMODYNAMICS**	**09**
	Qualitative difference between heat and work, cyclic heat engine, energy reservoirs, kelvin-planck and clausius statement of second law of thermodynamics, pmm 2, refrigerator and heat pump, equivalence of kelvin-planck and clausius statements, reversibility and irreversibility, causes and conditions of irreversibility, carnot cycle, reversed heat engine, carnot's theorem and its corollary, absolute thermodynamic temperature scale, efficiency of the reversible heat engine, equality of ideal gas and Kelvin temperatures, types of irreversibility, numericals.	
UNIT-4	**ENTROPY AND THERMODYNAMIC RELATIONS**	**13**
	Introduction, clausius theorem, The property of entropy, T-S plot, clausius inequality, entropy change in an irreversible process, entropy principle and its applications. T-ds relations, thermodynamic relations – Maxwell equation, Tds equations, difference in heat capacities, ratio of heat capacities, energy equation, Joule-Kelvin effect, clausius-clapeyron equation, numericals.	

UNIT-5	PROPERTIES OF PURE SUBSTANCES AND GASES	13
	P-V diagram and P-T diagram for a pure substance, p-v-T surface, T-s and h-s diagram for a pure substance, quality of pure substance, steam tables – saturation state, liquid-vapour mixture, compressed liquid, charts of thermodynamic properties, measurement of steam quality – throttling calorimeter, separating and throttling carlorimeter; avogadro's law, equation of state of gas, ideal gas - specific heat, internal energy and enthalpy, entropy change, thermodynamic property relations, work and heat transfer in reversible adiabatic, isothermal and poltropic processes of an ideal gas, integral property relations, generalised compressibility chart, other equations of state, numericals.	

TEXT BOOKS

1.**Engineering Thermodynamics**, P.K. Nag, Tata McGraw Hill Education (India) Publications, 5th Edition, 2013.

2.**A Text Book of Engineering Thermodynamics**, R.K. Rajput, Laxmi Publishers, 3rd Edition, 2010.

REFERENCE BOOKS

1.**Thermodynamics:An Engineering Approach**, Yunus A. Cenegal and Michael A. Boles, McGraw-Hill Publications (SIE), 8th Edition, 2015.

2.**Fundamentals of Thermodynamics**, Claus Borgnakke and Richard E. Sonntag, Wiley Student Edition, 7th Edition, 2009.

3.**Principles of Engineering Thermodynamics**: S.I. Version, Moran and Shapiro, Wiley Student Edition, 2013.

4. **Fundamentals of Engineering thermodynamics by** H . N. Shapiro & M J Moran.

e-LEARNING RESOURCES

1. **Videos and Lecture Notes:** http:// www.nptel.ac.in

DATA HAND BOOK

1. **Thermodynamics Data Book**, Richard E. Sonntag and Claus Borgnakke, Wiley Student Edition, 2nd Edition.

SYLLABUS COVERAGE FOR CIE

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)
CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each full question shall contain maximum of 3 subdivisions.

COURSE OUTCOME (CO)

After the completion of the course, the students will be able to:

1: Define and describe the thermodynamic system and its properties.

2: Interpret the laws of thermodynamics with examples and illustrations.
3: Sketch and draw the property variables on various thermodynamic planes.
4: Analyze the relations governing thermodynamic properties and their applications.
5: Apply knowledge of entropy and thermodynamic relations in various thermodynamic systems.
6: Evaluate the performance of engineering systems and processes based on laws of thermodynamics.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	1	1	1
6	3	3	2	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2017-18 ACADEMIC YEAR: 2018-19
SEMESTER : THIRD

COURSE TITLE : MECHANICS OF MATERIALS		
Sub Code: ME33	**No of Credits : L-T-P-SS 4:0:0:0=4**	**No. of lecture hours/week : 04**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Basic engineering mathematics**	

COURSE OBJECTIVES:
1. Understand mechanics of deformable bodies and apply them in analysis and design problems.
2. Analyze a body subjected to two dimensional and three dimensional stress systems.
3. Examine the stresses in thin and thick cylinders subjected to loads.
4. Evaluate the slope and deflection in beams subjected to different loading conditions.
5. Assess the stability of columns and struts.
6. Interpret the torsional behavior of structural members.

#	Contents	h
UNIT-1	**SIMPLE STRESS AND STRAIN**	**12**
	Introduction, Stress, strain, mechanical properties of materials, Linear elasticity, Hooke's Law and Poisson's ratio, Stress-Strain relation – Ductile & Brittle, materials. Extension / Shortening of a bar, bars with cross sections varying in steps, bars with continuously varying cross sections (circular and rectangular), Elongation due to self-weight, Principle of super position. Stress in Composite Section: Volumetric strain, expression for volumetric strain, elastic constants, simple shear stress, shear strain, temperature stresses (including compound bars). Compound Stresses: Introduction, Plane stress, stresses on inclined sections, principal stresses and maximum shear stresses, Mohr's circle for plane stress.	
UNIT-2	**BENDING MOMENT AND SHEAR FORCE IN BEAMS**	**12**
	Introduction, Types of beams, loads and reactions, shear forces and bending moments, rate of loading, sign conventions, relationship between shear force and bending moments. Shear force and bending moment diagrams for different beams subjected to concentrated loads, uniformly distributed load, (UDL) uniformly varying load (UVL) and couple for different types of beams. Bending and Shear Stresses in Beams: Introduction, Theory of simple bending, assumptions in simple bending. Bending stress equation, relationship between bending stress, radius of curvature, relationship between bending moment and radius of curvature. Moment carrying capacity of standard sections. Shearing stresses in beams, shear stress across rectangular, circular, symmetrical I and T sections. (Composite / notched beams not included).	
UNIT-3	**ENERGY METHODS**	**10**
	Work, strain energy, Strain energy in bar/beams due to various loads. **THIN & THICK CYLINDERS** Stresses in thin cylinders due to internal pressure, circumferential stresses & longitudinal stresses. Deformation in thin cylinders, stresses due to internal pressure of thick cylinders, Lame's theory and numerical problem.	
UNIT-4	**DEFLECTION OF BEAMS**	**8**
	Introduction, differential equation for deflection. Equations for deflection, slope and bending moment. Double integration method for cantilever and simply supported beams for point load, UDL, UVL and Couple. Macaulay's method	

UNIT-5	TORSION OF CIRCULAR SHAFTS AND ELASTIC STABILITY OF COLUMNS	10
	Introduction. Pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts. Power transmitted by solid and hollow circular shafts columns**:** Euler's theory for axially loaded elastic long columns. Derivation of Euler's load for various end conditions, limitations, Rankine's formula.	

TEXT BOOKS:

1.**"Strength of Materials",** S.S. Rattan, Tata McGraw Hill, 2009

2.**"Strength of Materials", S. Ramamrutham**

REFERENCE BOOKS:

1. **"Mechanics of materials",** James. M. Gere, Thomson, Fifth edition 2004.
2. **"Mechanics of materials",** in S.I. Units, Ferdinand Beer & Russell Johnstan, Tata McGraw Hill- 2003.
3. **"Strength of Materials",**S.S.Bhavikatti, Vikas publications House -1 Pvt. Ltd., 2nd Ed., 2006.
4. **"Engineering Mechanics of Solids**", Egor.P. Popov, Pearson Edu. India, 2nd, Edison, 1998.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1		2		3	4	5

SCHEME OF EXAMINATION (SEE):

1. ONE FULL QUESTION from UNIT-3, UNIT-4 and UNIT-5 are COMPULSORY.
2. TWO FULL QUESTIONS each with CHOICE from UNIT-1 and UNIT-2 ONLY.
3. MAXIMUM of THREE SUB-DIVISIONS in EACH FULL QUESTION.

COURSE OUTCOMES: On completion of the course, student should be able to;

1) Explain the concepts and principles applied to members under loadings, material properties.

2) Analyze structural members subjected to loads using the fundamental concepts of stress, strain and elastic behaviour of materials and thermal stresses.

3) Calculate the stresses on inclined plane by graphical method – Mohr’s circle concept for different stress conditions

4) Develop BM & SF diagrams for cantilever & simply supported beams with different load conditions.

5) Relate bending stress, bending moment, radius of curvature, express shear stress in beams of different cross sections, and determine the deflection of beams subjected to different loads.

6) Analyze different machine elements such as shafts, pressure vessels for strength, rigidity and internal, external pressure respectively.

ADMISSION YEAR : 2017-18 ACADEMIC YEAR: 2018-19
SEMESTER : THIRD

COURSE TITLE : MANUFACTURING PROCESS – I		
Sub Code: ME34	**No of Credits : L-T-P-SS 4:0:0:0=4**	**No. of lecture hours/week : 04**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Elements of mechanical engineering**	

COURSE OBJECTIVES:

1. This course will introduce the student to the various manufacturing processes.
2. The course will begin by examining manufacturing processes including casting and welding processes.
3. For each manufacturing process, capabilities and limitations will be discussed.

#	CONTENTS	Hrs
UNIT-1	**MOULDING MATERIALS**	08
	Introduction: Concept of manufacturing process, its importance. Classification of manufacturing processes. Introduction to casting process & steps involved. Components varieties, of produced by casting processes. Advantages & limitations of casting processes. Patterns: Definition, functions, materials used for pattern, various pattern allowances and their importance. Classification of patterns, BIS colour coding of patterns. Binder: Definition, Types of binder used in moulding sand. Additives: need, types of additives used and their properties.	
UNIT-2	**MOULDING PROCESSES**	08
	Sand moulding: Types of base sand, requirement of base sand. moulding sand mixture, ingredients for different sand mixtures. Method used for sand moulding such as green sand, dry sand and skin dried moulds. Cores: Definition, need, types, method of making cores, binders used, core sand moulding, concept of gating and risering.	
UNIT-3	**MELTING FURNACES**	
	Classification of furnaces, Constructional features & working principle of coke fired, oil fired and gas fired pit furnace, resistance furnace, coreless induction furnace, electric arc furnace, Cupola furnace and process parameters.	06
UNIT-4	**CASTING AND WELDING PROCESSES**	
	Casting processes: Moulding machines: Jolt type, Squeeze type, Jolt & Squeeze type and sand slinger. Gravity die-casting, pressure die casting, centrifugal casting, and continuous casting processes. Welding processes: Introduction, definition, principles, classification, application, advantages & limitations of welding. Arc welding: Principle, metal arc welding (MAW), flux shielded metal arc welding (FSMAW), inert gas welding (TIG & MIG). Briefing about latest welding processes. Resistance welding: Principles, seam welding, butt welding, spot welding and projection welding, friction welding, explosive welding, thermit welding.	16
UNIT-5	**METALLURGICAL ASPECTS OF CASTING AND WELDING**	

	Metallurgical aspects: Study of important moulding processes, Sweep mould, CO2 mould, Shell mould, Flask less moulds, Investment mould. Casting defects, causes, features and remedies. Structure of welds, formation of different zones during welding. Heat affected zone (HAZ), parameters affecting HAZ. Effect of carbon content on structure and properties of steel. Welding defects – Detection causes & remedy. Inspection methods : Methods used for inspection of casting and welding. Visual, magnetic particle, fluorescent particle, ultrasonic, radiography, eddy current, holography methods of inspection.	14

TEXT BOOKS:

1. **"Manufacturing Process-I & II",** Dr. K. Radhakrishna, Sapna Book House, 5^{th}Revised Edition 2009.
2. **"Manufacturing & Technology**: Foundry Forming and Welding", P.N. Rao 2^{nd}Ed., TMH, 2003.
3. **Manufacturing Science**, Amitabha Ghoshand Mallik, affiliated East West Press,2003.
4. **Metal Casting: Principles and Practice**, T.V. RamanaRao,Published by NewAge International (P) Limited (2010)
5. **Principles of Metal Casting,** MahiSahoo **,** Sam Sahu **, McGraw Hill Education (India) Private Limited; Third edition (26 September 2014)**

REFERENCE BOOKS:

1. **"Manufacturing Technology**", Serope Kalpakjain, Steuen.R. Sechmid, Pearson Education Asia, 5^{th} Ed. 2006.
2. **"Process and Materials of Manufacturing**", Roy A Lindberg, 4^{th}Ed. Pearson Edu. 2006.
3. **Principles Of Metal Casting- Second Edition**, Heine, Richard W.; CarlR. Loper, Jr. & Philip C. Rosenthal, Published by McGraw-Hill, New York (1967)
4. **Mechanical Metallurgy Paperback ,** George E. Dieter**TMH**

Syllabus Coverage for CIE

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)
CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each full question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES: On completion of the course, student should be able to;

1) Differentiate different manufacturing processes, select a particular casting process for a given application.
2) Compare capabilities and characteristics of different sand and special moulding processes.

3) Understand the working principle and capabilities of different melting furnaces followed by understanding the special features and capabilities of different casting processes.
4) Apply particular welding process to produce sound weld.
5) Analyze the causes, features and remedies of casting and welding defects

MAPPING OF COs WITH POs

COs/POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	1	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2017-18 ACADEMIC YEAR: 2018-19
SEMESTER : THIRD

COURSE TITLE : METROLOGY AND MEASUREMENTS		
Sub Code: ME35	**No of Credits : L-T-P-SS 3:0:0:0=3**	**No. of lecture hours/week : 03**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Engineering physics, Basic electrical engineering**	

COURSE OBJECTIVES:
1. Explain the concepts of measurement and gauging instruments.
2. To provide knowledge on various metrological equipment's available to measure the dimension of the components.
3. To provide knowledge on the correct procedure to be adopted to measure the dimension of the components.
4. Explain and apply the principles in manufacturing industries.

#	CONTENTS	h
UNIT-1	**STANDARDS OF MEASUREMENT**	**07**
	Measurement: Definition and Objectives of metrology, standards of length international prototype meter, imperial standard yard, wave length standard, subdivision of standards, line and end standard, calibration of end bars (Numerical), slip gauges, wringing phenomena, Indian standards (M-81, M-12), numerical problems on building of slip gauges. system of limits, fits, tolerance and gauging: definition of tolerance, specification in assembly, principle of inter-changeability and selective assembly limits of size, indian standards, concept of limits of size and tolerances, compound tolerances, accumulation of tolerances, definition of fits, types of fits and their designation (IS919-1963),geometrical tolerance, positional-tolerances, hole basis system, shaft basis system.	
UNIT-2	**GAUGES AND LINEAR MEASUREMENTS**	**06**
	Brief concept of design of gauges (Taylor's principles), wear allowance on gauges, types of gauges-plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials. comparators: introduction to comparators, characteristics, classification of comparators, mechanical comparators-Johnson Mikrokator, sigma comparators, dial indicator, optical comparators-principles, Zeiss ultra-optimeter, electric and electronic comparators-principles, LVDT, pneumatic comparators, back pressure gauges, solex comparator .	
UNIT-3	**ANGULAR MEASUREMENTS AND INTERFEROMETRY**	**06**
	Angular measurements: bevel protractor, sine principle and use of sine bars, sine center, use of angle gauges (numericals on building of angles), and clinometers. **Measurement of surface roughness:** Parameters of 2D and 3D surface parameters. Measurement of form-Straightness, flatness, perpendicularity, parallelism, roundness and cylindrical. **Interferometry**: Interferometer, autocollimator. Optical flats. Terminology of screw threads, profile projector- measurement of major diameter, minor diameter, pitch, angle and effective diameter of screw threads by 2-wire and 3-wire methods, tool maker's microscope, gear tooth,	

	terminology, use of gear tooth vernier caliper and micrometer.	
UNIT-4	**MEASUREMENT SYSTEMS AND TRANSDUCERS**	**10**
	Measurements and measurement systems: Definition, significance of measurement, generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hysterisis, repeatability, linearity, loading effect, system response-times delay. Errors in measurement, classification of errors. **Transducers:** transfer efficiency, primary and secondary transducers, electrical, mechanical, electronic transducers, advantages of each type of transducers. **Intermediate modifying and terminating devices:** Mechanical systems, electronic amplifiers and telemetry. Terminating devices, mechanical, cathode ray oscilloscope, oscillographs, X-Y plotters.	
UNIT-5	**MEASUREMENT OF FORCE,TORQUE,PRESSURE AND TEMPERATURE MEASUREMENTS**	**10**
	Force and torque measurements: proving ring, dynamometers. **Pressure measurements:** Principle, use of elastic members, Bridgeman gauge, McLeod gauge. **Temperature and strain measurements:** Resistance thermometers, thermocouple, law of thermocouple, materials used for construction, pyrometer, optical pyrometer. Strain measurements, preparation and mounting, gauge factor, methods of strain measurement, Co-ordinate measuring machine (CMM) - principle of operation, working and applications.	

TEXT BOOKS:

1. **Mechanical Measurements,** Beckwith Marangoni and Lienhard, Pearson Education, 6th Edition, 2006. (For Measurements Only)
2. **Engineering Metrology,** R.K. Jain, Khanna Publishers, 1994. (For Metrology Only)

REFERENCE BOOKS:

1. **Engineering Metrology,** I.C. Gupta, Dhanpat Rai Publications, Delhi.
2. **Mechanical Measurements,** R.K. Jain
3. **Industrial Instrumentation,** Alsutko, Jerry. D. Faulk, Thompson Asia Pvt. Ltd.2002.
4. **Measurement Systems Applications and Design,** Ernest O. Doblin, McGraw Hill

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)
(Irrespective of portions covered due to whatever might be the reason)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit 5.
3. Each full question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES:

1) Describe different standards and the importance of standardization.
2) Recognize measurements necessity, various dimensional measurements.
3) Design measurement system for a given parameter
4) List the different kinds of sensors, transducers, and recorders.
5) Assess measurement system with its limitations.

MAPPING OF COs WITH POs

COs/POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	1	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2017-18 ACADEMIC YEAR: 2018-19
SEMESTER : THIRD

COURSE TITLE : COMPUTER AIDED MACHINE DRAWING		
Sub Code: ME36	**No of Credits : L-T-P-SS 2:0:4:0 =4**	**No. of lecture hours/week : 06**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 50**
Pre-requisites	**Computer Aided Engineering Drawing, Solid edge software**	

COURSE OBJECTIVES:
1. To understand the sectional views and developments of various solid shapes.
2. Simple machine parts orthographic views with and without sections to be under-stood.
3. Different types of thread forms to be studied.
4. Permanent and temporary fasteners study
5. Assembly drawings in 2D of several joints.

#	CONTENTS	Hr
UNIT-1	**SECTIONS OF SOLIDS AND ORTHOGRAPHIC PROJECTIONS**	**16**
	Introduction to geometrical dimensions & tolerances, **Sections of solids:** Prisms, pyramids, cones, cylinders cut by a single section plane perpendicular to vertical plane and inclined to horizontal plane **Orthographic projections:** Orthographic views of simple machine parts with and without sections	
UNIT-2	**THREAD FORMS FASTENERS, KEYS & JOINTS RIVETED JOINTS**	**16**
	Thread Forms: Thread forms: thread terminology, sectional views of threads. ISO Metric (internal & external) BSW (internal & external) square and Acme. Sellers thread, American Standard thread. **Fasteners:** Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut, flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw. **Keys & Joints**: Keys & joints: parallel key, taper key, feather key, gib head key and woodruff key. **Riveted joints:** Single and double riveted lap joints, butt joints with single/double cover straps (chain and zigzag, using snap head rivets). Cotter joint (socket and spigot), knuckle joint (pin joint) for two rods.	
UNIT-3	**ASSEMBLY DRAWINGS**	**20**
	Screw jack (Bottle type), Plummer block (Pedestal bearing) and Machine vice	

TEXT BOOKS:
1. **Computer Aided Machine Drawing 2007,** Published by VTU, Belgaum

REFERENCE BOOKS:
1. **Machine Drawing'**, K.R. Gopala Krishna, Subhash Publication.
2. **Machine Drawing',** N. D. Bhat& V. M. Panchal
3. **Computer Aided Machine Drawing'** Trymbaka Murthy, CBS Publishers, New Delhi 2007

CONTINUOUS INTERNAL EVALUATION (CIE)

1. CIE has a maximum of 50 marks
2. All the sheets should be drawn in the class using Solid edge software. Sheet sizes should be A4. All sheets must be submitted at the end of the class by taking printouts.
3. CIE Marks is finalized by conducting a test at the end of 10 week of the semester
4. CIE Marks (50) = Evaluation of Record (Sketch-15 and Printout-15) + Test (20)

SCHEME OF EXAMINATION (SEE):

1. Total number of full questions to be set: 06.
2. Two question to be set from each unit compulsorily.
3. Student has to answer one question from each unit.

UNIT-1	**10 MARKS**
UNIT-2	**10 MARKS**
UNIT-3	**30 MARKS**
TOTAL	**50 MARKS**

COURSE OUTCOMES:

On completion of the course, student should be able to;

1. Viewing a section with a specific orientation to understand interior details.
2. Identifying several thread forms and pinpointing their usage.
3. Realise fasteners and their importance with specific decision to select the right type of fastener for the right job.
4. Make assembly of various parts of joints and couplings.

MAPPING OF Cos WITH Pos

COs/POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	1	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2017-18 **ACADEMIC YEAR: 2018-19**
SEMESTER : THIRD

COURSE TITLE : MANUFACTURING PROCESS LABORATORY - I		
Sub Code: MEL37	**No of Credits : L-T-P-SS 0:0:2:0 = 1**	**No. of lecture hours/week : 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 50**
Pre-requisites	**Manufacturing Process - I**	

COURSE OBJECTIVES:
1. This course will give the student knowledge of testing sand used in foundries.
2. It also focuses on preparation of sand moulds, forging a component.

#	Contents	Hrs
PART A	**TESTING OF MOLDING SAND AND CORE SAND**	**08**
	Preparation of sand specimens and conduction of the following tests: 1. Compression, shear and tensile tests on universal sand testing machine. 2. Permeability test 3. Core hardness &mould hardness tests. 4. Sieve analysis to find Grain Fineness number of base sand 5. Clay content determination in base sand	
PART B	**FOUNDRY PRACTICE**	**09**
	Use of foundry tools and other equipment's. Preparation of moulds using two moulding boxes using pat-terns or without patterns. (Split pattern, match plate pattern and Core boxes). Preparation of one casting (Aluminum or cast iron-Demonstration only)	
PART C	**FORGING OPERATIONS**	09
	Calculation of length of the raw material required to do the model. Preparing minimum three forged models involving upsetting, drawing and bending operations. Out of these three models, at least one model is to be prepared by using Power Hammer.	

REFERENCE BOOKS:

1. "Manufacturing & Technology Foundry Forming and Welding", P.N. Rao 2 Ed.,Tata McGraw Hill, 2003.
2. Manufacturing Science, Amitabha Ghosh and Mallik, affiliated East West Press,2003.
3. Metal Casting: Principles and Practice, T.V. RamanaRao,Published by NewAge
4. Principles of Metal Casting,MahiSahoo, Sam Sahu**McGraw Hill Education (India) Private Limited; Third edition (26 September 2014).**

CONTINUOUS INTERNAL EVALUATION (CIE)
1.CIE has a maximum of 50 marks.
2.CIE Marks is finalized by conducting a test at the end of 10^{th} week of the semester.
3.CIE Marks (50) = Evaluation of Record (30) + Test (20)

SCHEME OF EXAMINATION (SEE):

One Compulsory experiment from PART A	15 MARKS
One Model either from PART B or PART C	25 MARKS
Viva – Voce	10 MARKS
TOTAL	50 MARKS

COURSE OUTCOMES: On completion of the course, student should be able to:

1. Test and analyze the properties of sand used in foundries as per international standards.
2. Develop a mould for simple applications.
3. Fabricate a simple forging components using different tools.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2017-18 ACADEMIC YEAR: 2018-19
SEMESTER : THIRD

COURSE TITLE : METROLOGY AND MEASUREMENTS LABORATORY		
Sub Code: MEL38	**No of Credits : L-T-P-SS 0:0:2:0 = 1**	**No. of lecture hours/week : 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 50**
Pre-requisites		

COURSE OBJECTIVES:
1. Calibration of vital tools including micrometer in measurements laboratory
2. Calculate modulus of elasticity of a ductile specimen
3. Measurement of parameters like; Angle, Alignment, Cutting tool forces, Screw thread, Surface roughness and Gear tooth profile

#	**Contents**	**Hrs**
PART A	**MEASUREMENTS**	**12**
	1. Calibration of Pressure Gauge 2. Calibration of Thermocouple 3. Calibration of LVDT 4. Calibration of Load cell 5. Determination of modulus of elasticity of a ductile specimen using strain gauges	
PART B	**METROLOGY**	**14**
	1. Measurements using Optical Projector / Toolmaker Microscope. 2. Measurement of angle using Sine bar / bevel protractor 3. Measurement of alignment using Autocollimator. 4. Measurement of cutting tool forces using-Lathe tool & Drill tool Dynamometer. 5. Measurements of Surface roughness, using Tally Surf/Mechanical Comparator 6. Measurement of gear tooth profile using gear tooth vernier /Gear tooth micrometer 7. Calibration of Micrometer using slip gauges 8. Measurement using Optical Flats	

REFERENCE BOOKS:

1. **Mechanical Measurements,** Beckwith Marangoni and Lienhard, Pearson Education, 6th Edition, 2006. (For Measurements Part Only)
2. **Engineering Metrology,** R.K. Jain, Khanna Publishers, 1994
3. . **'Mechanical Measurements and Metrology',** Dr. T. Chandrasekhar, Sub hash Stores, 3rd Edition, 2009.

CONTINUOUS INTERNAL EVALUATION (CIE)
1.CIE has a maximum of 50 marks.
2.CIE Marks is finalized by conducting a test at the end of 10th week of the semester.
3.CIE Marks (50) = Evaluation of Record (30) + Test (20)

SCHEME OF EXAMINATION (SEE):

One from PART A	15 MARKS
One from PART B	25 MARKS
Viva – Voce	10 MARKS

TOTAL	50 MARKS

COURSE OUTCOMES:

1. Vital tools calibration methods are understood in the metrology section
2. To the measurements section several important parameters are measured using several versatile equipment's.

ADMISSION YEAR : 2017-18 ACADEMIC YEAR: 2018-19
SEMESTER : FOURTH

COURSE TITLE : TURBOMACHINES		
Sub Code: ME41	**No of Credits : L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week : 04**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Fluid mechanics, Engineering thermodynamics**	

COURSE OBJECTIVES

1. This course outlines the working principle of turbo machines with examples. Classifies turbo machines and describes the energy transfer mechanism of turbo machines. Apply dimensional analysis and similarity laws for conducting model tests.
2. It also helps students to explain the functioning of radial flow and axial flow turbo machines such as centrifugal pumps, compressors, steam, gas and hydraulic turbines
3. This course helps students to demonstrate the effect of important variables affecting the output of turbo machines.
4. The course is useful to sketch the velocity diagrams for various types of turbo machines
5. This course helps students to analyze a given problem, apply the fundamental knowledge to solve the problem
6. This course helps students estimate and evaluate unknown parameters and predict the performance of turbo machines

#	CONTENTS	hours
UNIT-1	**INTRODUCTION AND DIMENSIONAL ANALYSIS**	**10**
	Introduction: Definition of a turbo machine; parts of a turbo machine; comparison with positive displacement machine; classification; Energy transfer in a turbo machine - Euler turbine equation; alternate form of Euler turbine equation (components of energy transfer); degree of reaction, utilization factor and relationship between them. **Dimensional Analysis:** Introduction, derived quantities, dimensions of physical quantities, dimensional homogeneity, Rayleigh's method, Buckingham π theorem, dimensionless numbers, and similitude, types of similitude, dimensional analysis and similarity studies. Numerical problems.	
UNIT-2	**GENERAL ANALYSIS OF RADIAL AND AXIAL FLOW TURBOMACHINES**	**10**
	General analysis of radial flow turbo machines (turbines and pumps) - Effect of blade discharge angle on their performance; Theoretical head-capacity relationship; Related numerical problems. **General analysis of axial flow turbines** – utilization factor, degree of reaction, relationship between utilization factor and blade speed ratio; Maximum utilization factor and optimum blade speed ratio for impulse and reaction axial flow turbines; General analysis of axial flow compressors and pumps – general expression for energy transfer and degree of reaction; Related numerical problems.	
UNIT-3	**STEAM TURBINES**	**08**
	Introduction; Different efficiencies; Analysis of single stage impulse (De Laval) turbine; Impulse staging and need for compounding; Analysis of velocity compounded impulse (Curtis) turbine; Analysis of Impulse-reaction (Rateau) turbine; Reheat factor for multi stage turbine; Related numerical problems.	

UNIT-4	HYDRAULIC TURBINES	12
	Introduction; Classification; Different heads and efficiencies; Pelton turbine-velocity triangles; Francis turbine-velocity triangles, runner shapes for different blade speeds; function of a draft tube, types of draft tube; Kaplan and Propeller turbines – velocity triangles and analysis; Related numerical problems; Specific speed and its significance; Unit quantities and their uses; Characteristic curves of hydraulic turbines.	
UNIT-5	**CENTRIFUGAL PUMPS AND COMPRESSORS**	**12**
	Centrifugal pumps –Introduction, Main parts of a centrifugal pump; Work done; Definitions of heads and efficiencies; minimum speed for starting; Multistage centrifugal pump; Specific speed; Priming; Characteristic curves; Cavitation; Thoma's cavitation factor;; Maximum suction lift; Net positive suction head; Related numerical problems: Centrifugal compressors-Introduction; Work done; Overall pressure ratio developed; Pressure ratio in terms of ϕ_s, ϕ_p, ϕ_w; Compressibility and pre-whirl; Diffuser design; Surging; Related numerical problems.	

TEXT BOOKS

1. **Turbo Machines**, Dr. N. Krishnamurthy, Sunstar Publisher, 2nd Edition, 2015.
2. **A Textbook of Fluid Mechanics and Hydraulic Machines (SI Units)**, Dr. R.K. Bansal, Laxmi Publications (P) Limited, Revised 9th Edition, 2010.
3. **Turbomachines**, B.U. Pai, Wiley Precise Textbook Series, 2014.

REFERENCE BOOKS

1. **A Textbook of Turbo Machines**, Dr M S Govindegowda and Dr A M Nagaraja,8th Edition, M M Publishers, 2014
2. **An introduction to energy conversion, Vol. III – Turbomachinery**, V. Kadambi and Manohar Prasad, 2nd Edition, New Age International Publishers (P) Limited, 2011.
3. **Principles of turbomachinery**, D. G. Shepherd, MacMillan Company, 1964.

QUESTION PAPER PATTERN (SEE)

#	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit5.
3. Each question shall contain maximum of 3 subdivisions.

COURSE OUTCOME (CO)

After the completion of the course, students will be able to:
1: Describe the general working of turbo machines, define non dimensional numbers, analyze dimensions of physical quantities, and evaluate non dimensional numbers.
2: Illustrate the functioning of radial flow and axial flow turbo machines with examples.
3: Sketch and draw the velocity diagrams for turbo machines.
4: Classify and analyze the various types of turbo machines.
5: Derive various equations related to the performance of turbo machines
6: Evaluate and compute the performance of various turbo machines.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	2	1	2	1	1	1	1	1	1	1
2	3	3	3	1	2	1	1	1	1	2	1	1
3	3	3	2	1	1	1	1	1	1	2	1	1
4	3	3	3	1	2	1	1	1	1	2	1	1
5	3	3	2	1	2	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	1	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2017-18 ACADEMIC YEAR: 2018-19
SEMESTER : FOURTH

COURSE TITLE : APPLIED THERMODYNAMICS		
Sub Code: ME42	**No of Credits : L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week : 04**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Fluid mechanics, Engineering thermodynamics**	

COURSE OBJECTIVES

1. To relate the fundamentals of thermodynamics to the real time applications.
2. To describe the various thermodynamic power cycles which use air and vapour as the working fluid
3. To apply the fundamental concepts to derive various thermodynamic variables for solving numerical problems
4. To design and develop various thermodynamic systems and predict their performance.

#	CONTENTS	h
UNIT-1	**AIR STANDARD POWER CYCLES**	**10**
	Introduction; air standard cycles - description of various processes, p-v and t-s diagrams, derivation of efficiency and mean effective pressure of carnot, otto, diesel and dual combustion cycles, related numerical problems. testing and performance of IC engines: basic measurements – engine speed, fuel consumption, air consumption, exhaust Smoke, IP, BP, FP measurements, heat balance sheet – numerical problems	
UNIT-2	**RECIPROCATING COMPRESSORS**	**08**
	Introduction; working principle, p-v diagram and derivation of work input of a single stage reciprocating compressor; adiabatic, isothermal and mechanical efficiencies; effect of clearance and derivation of volumetric efficiency; multistage compressor; saving in work, optimum intermediate pressure, inter-cooling, minimum work for compression; related numerical problems.	
UNIT-3	**VAPOUR POWER CYCLES**	**10**
	Introduction; performance parameters; Carnot vapour power cycle; Rankine cycle; actual vapour power cycle; comparison of Rankine and Carnot cycles; mean temperature of heat addition; reheat cycle; ideal and practical regenerative cycle; reheat-regenerative cycle; feedwater heaters; numerical problems on Carnot cycle, Rankine cycle, reheat cycle and regenerative cycle.	
UNIT-4	**REFRIGERATION CYCLES AND PSYCHROMETRY**	**12**
	Introduction; Refrigerants, Selection of a refrigerant, Units of refrigeration- TOR; COP; Reversed carnot cycle; vapour compression refrigeration cycle; actual vapour compression cycle; effect of change in operating conditions on the performance of vapour compression cycle; vapour absorption refrigeration system, steam jet refrigeration system; gas cycle refrigeration; numerical problems on vapour compression cycles. **Psychometry:** Definitions of terms related to Psychometry – WBT, DBT, DPT, specific humidity, relative humidity, enthalpy, psychrometric chart, psychometric process, summer and winter air conditioning, numerical Problems.	
UNIT-5	**GAS TURBINE CYCLES AND JET PROPULSION**	**12**
	Introduction; Analysis of simple gas turbine cycle (Brayton cycle); methods to improve the performance of gas turbine plant – efficiency of regenerative gas turbine cycle; reheat gas turbine cycle; gas turbine cycle with intercooling; gas turbine cycle with reheat, regeneration and intercooling; numerical problems on simple gas turbine cycle with	

	reheating, regeneration, and intercooling. **Jet Propulsion –** Introduction to jet propulsion**,** gas turbine cycles for jet propulsions, working of ram jet engine, pulse jet engine, turbo jet engine, turboprop engine, comparisons of various propulsive devices, numerical problems	

TEXT BOOKS

1. **Basic and Applied Thermodynamics,** P.K. Nag, Tata McGraw-Hill Publications, 2nd Edition, 2010.
2. **Applied Thermodynamics,** Omkar Singh, New Age International (P) Limited, 2003.
3. **Gas Turbines,** V Ganeshan,Tata McGraw-Hill Publications, 2nd Edition, 2003.
4. **Gas Turbines and Jet Rocket Propulsion**, V.M. Domkundwar, DhanpatRai& Co. (P) Limited, 2nd Edition, 2013.

REFERENCE BOOKS

1. **A Course in Thermal Engineering,** A. Domkundwar, C.P. Kothandaraman, S. Domkundwar, DanpatRai and Co (P) Limited, 2013.

e-LEARNING RESOURCES

1. **Videos and Lecture notes:** http:// www.nptel.ac.in

DATA HAND BOOKS AND CHARTS

1. **Thermodynamics Data Hand Book(SI Units),** B T Nijaguna and B S Samaga, Sudha Publications, 2016.
2. **Steam Tables with Mollier Diagram: SI Units**, Mahesh M. Rathore, DhanpatRai Publishing Company, 2014.
3. **Refrigeration Tables and Charts: SI Units,** C.P. Kothandaraman**,** 4th Edition, New Age International Publishers, 2015.

SYLLABUS COVERAGE FOR CIE

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (First 50%)
CIE-3: UNIT 4 (Last 50%) + UNIT 5 (100%)

QUESTION PAPER PATTERN (SEE)

#	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit5.
3. Each question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES (CO)

After the completion of the course, students will be able to:
1: Identify and describe thermodynamic power cycles and refrigeration cycles.
2: Explain the various thermodynamic cycles giving examples and illustrations.
3: Sketch and draw thermodynamic cycles to solve for various parameters by applying the basic principles of thermodynamics.

4: Compare and analyse different types of thermodynamic cycles.
5: Derive various expressions to measure the performance of thermodynamic power cycles and refrigeration cycles.
6: Calculate and compute the performance of various thermal engineering systems.

MAPPING OF COs WITH POs

COs/POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	2	1	1	1	1	1	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	2	1	1	1	1	3	1	1
6	3	3	3	1	3	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2017-18 ACADEMIC YEAR: 2018-19
SEMESTER : FOURTH

COURSE TITLE : KINEMATICS OF MACHINES		
Sub Code: ME43	**No of Credits : L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week : 04**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Basic engineering mathematics**	

COURSE OBJECTIVES:
1) Explain the types of relative motion.
2) Differentiate between Machine, Mechanism, and Structure.
3) Draw the velocity and acceleration diagram of various linkages.
4) Determine the gear parameters and check for interference.
5) Calculate the fixing torque in gear trains.
6) Design the Cam profile for the desired follower motion.

#	CONTENTS	h
UNIT-1	**INTRODUCTION**	**12**
	Definitions Link or element, kinematic pairs, degrees of freedom, Grubler's criterion (without derivation), Kinematic chain, mechanism, structure, mobility of mechanism, inversion, machine. **Kinematic chains and inversions -** Inversions of four bar chain; single slider crank chain and double slider crank chain practical applications. **Mechanisms -** Quick return motion mechanisms-drag link mechanism, whitworth mechanism and crank and slotted lever mechanism. Straight line motion mechanisms Peaucellier's mechanism and Robert's mechanism. Intermittent motion mechanisms -Geneva wheel mechanism and Ratchet and Pawl mechanism. Toggle mechanism, Pantograph, Ackerman steering gear mechanism,. All wheel drive mechanism, power steering, Antilock Braking System.	
UNIT-2	**VELOCITY AND ACCELERATION ANALYSIS OF MECHANISMS (GRAPHICAL METHODS)**	**10**
	Velocity and acceleration analysis of four bar mechanism, slider crank mechanism and simple mechanisms by vector polygons: relative velocity and acceleration of particles .in a common link, relative velocity and accelerations of coincident particles on separate links-Coriolis component of acceleration. Angular velocity and angular acceleration of links, velocity of rubbing, Numericals.	
UNIT-3	**VELOCITY ANALYSIS BY INSTANTANEOUS CENTER METHOD**	**08**
	Definition, Kennedy's Theorem, determination of linear and angular velocity using instantaneous center method, Numericals. **KLEIN'S CONSTRUCTION**: Analysis of velocity and acceleration of single slider crank mechanism, Numericals.	
UNIT-4	**GEARS**	**12**
	Spur gears and its terminology, law of gearing, characteristics of involute action, path of contact, arc of contact, contact ratio of spur, helical, bevel and worm gears, interference in involute gears. Methods of avoiding interference, backlash, comparison of involute and cycloidal teeth, Numericals. **GEAR TRAINS:** Simple gear trains, Compound gear trains for large speed reduction, Epicyclic gear trains, reverted gear trains Algebraic and tabular methods of finding velocity ratio of Epicyclic gear trains. Tooth load and torque calculations in Epicyclic gear trains, Numericals.	

UNIT-5	CAMS	10
	Types of cam and follower. Displacement, velocity and, acceleration time curves for cam profiles, disc cam with reciprocating follower having knife-edge, roller and flat-face follower, disc cam with oscillating roller follower. Follower motions including SHM, uniform velocity, uniform acceleration and retardation and cycloidal motion, Problems.	

COURSE OUTCOMES: On completion of the course, student should be able to;
1) Identify the types of Kinematic motion in machines used in practice.
2) Calculate the velocity and acceleration of linkages using graphical, analytical, and vector approaches.
3) Synthesize mechanisms for prescribed path and motion generation using graphical, analytical, and computational methods.
4) Design the cam profile for the desired follower motion for applications such as IC engine valves, machine tools.
5) Estimate the gear tooth parameters and train value for different types of gear trains.

TEXT BOOKS:
1. **"Theory of Machines",** Thomas Bevan
2. **"Theory of Machines",** Rattan S.S, Tata McGraw-Hill Publishing Company Ltd., New Delhi, and 3rd edition -2009.
3. **"Theory of Machines",** Sadhu Singh, Pearson Education (Singapore) Pvt. Ltd, Indian Branch New Delhi, 2nd Edi. 2006

REFERENCE BOOKS:
1. **"Theory of Machines & Mechanisms**", J.J. Uicker, G.R. Pennock, J.E. Shigley. OXFORD 3rd Ed. 2009.
2. **Mechanism and Machine theory**, Ambakar, PHI

Graphical Solutions may be obtained either on the Graph Sheets or on the Answer Book itself.

REMINDER
BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)
(Irrespective of portions covered due to whatever might be the reason)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1		2	3	4		5

<u>Scheme of Examination (Question Paper Pattern)</u>
1. Seven Full Questions to be set and Five full Questions to be answered.
2. Unit-2, Unit-3 and Unit-5 are compulsory, with one question from each Unit and from Unit-1 and Unit-4: Two questions to be set with choice

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	1	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2017-18 ACADEMIC YEAR: 2018-19
SEMESTER : FOURTH

COURSE TITLE : MANUFACTURING PROCESS – II		
Sub Code: ME44	**No of Credits : L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week : 04**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Elements of mechanical engineering, Manufacturing process I**	

COURSE OBJECTIVES:
1. To expose the students to a variety of manufacturing processes including their typical use and Capabilities.
2. To teach the students mechanical aspects of manufacturing processes, such as cutting force, tool life.
3. To provide students a technical understanding of common traditional processes and non-traditional processes to aid in appropriate process selection for the material and required tolerances.

#	CONTENTS	Hrs
UNIT-1	**THEORY OF METAL CUTTING** Single point cutting tool nomenclature, geometry. Mechanics of Chip Formation, Types of Chips. Merchants circle diagram and analysis, Ernst Merchant's solution, shear angle relationship, problems on Merchant's analysis. Tool Wear and Tool failure, tool life. Effects of cutting parameters on tool life. Tool Failure Criteria, Taylor's Tool Life equation. Problems on tool life evaluation. **CUTTING TOOL MATERIALS** Desired properties and types of cutting tool materials – HSS, carbides, coated carbides, ceramics. Cutting fluids. Desired properties, types and selection. Heat generation in metal cutting, factors affecting heat generation. Heat distribution in tool and work piece and chip. Measurement of tool tip temperature.	10
UNIT-2	**BASIC MACHINE TOOLS** **TURNING (LATHE), SHAPING AND PLANING MACHINES** Classification, constructional features of Turret and Capstan Lathe. Tool Layout, Shaping Machine, planing machine, Driving mechanisms of lathe, shaping and planing machines, Different operations on lathe, shaping machine and planing machine. Simple problems on machining time calculations.	08
UNIT-3	**DRILLING AND MILLING MACHINES** Classification, constructional features, drilling & related operations. Types of drill & drill bit nomenclature, drill materials, milling cutters nomenclature, milling operations, up milling and down milling concepts. Various milling operations. Indexing: Simple, compound, differential and angular indexing calculations. Simple problems on simple and compound indexing.	08
UNIT-4	**GRINDING AND FINISHING PROCESSES** **GRINDING** Types of abrasives, Grain size, bonding process, grade and structure of grinding wheels, grinding wheel types. Classification, constructional features of grinding machines (centerless, cylindrical and surface grinding). Selection of grinding wheel. Grinding process parameters. Dressing and truing of grinding wheels. **BROACHING**	13

	Principle of broaching. Details of a broach. Types of broaching machines-constructional details. Applications, advantages and limitations. **FINISHING PROCESSES**: Lapping and Honing operations – Principles, arrangement of set up and application. **SUPER FINISHING PROCESS**: Polishing, buffing operation and application.	
UNIT-5	**NON-TRADITIONAL MACHINING PROCESSES:** Classification, Mechanism of material removal, Principle of working, process parameters, process capabilities, application and limitations of ECM, EDM, WEDM and USM. **FORGING:** Classification of forging processes, forging machines and equipment's, .Expressions for forging pressures and load in open die forging and closed die forging by slab analysis, concept of friction hill and factors affecting it. Die-design parameters. Material flow lines in forging. Forging defects, Residual stresses in forging. Simple problems.	13

TEXT BOOKS:

1. **Workshop Technology,** Hajra Choudhry, Vol-II, Media Promoters& Pub. Pvt. Ltd. 2004
2. **Production Technology,** R.K.Jain, Khanna Publications, 2003.
3. **Production Technology,** HMT, Tata McGraw Hill, 2001.
5. Manufacturing Technology - Vol. 2, P N Rao, TMH Education; 3rdedition (1 May 2013)
6. **Production Technology** ,R.K.Jain, Khanna Publications, 2003.
7. Production Technology, P.C. Sharma, S Chand (1 December 2006)

REFERENCE BOOKS:

1. **Manufacturing Science**, Amitabha Ghosh and Mallik, affiliated East West Press, 2003.
2. **Fundamentals of Metal Machining and Machine Tools,** G.Boothroyd, McGraw Hill, 2000.

QUESTION PAPER PATTERN (SEE)

#	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit5.
3. Each question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES: On completion of the course, student should be able to;

1) Understand and analyze the effect of temperature, strain rate in metal working, heat affected zones and learn different tool materials.

2) Describe the different machining operations performed on lathe, shaping, planning, milling and drilling along with their features.

3) Differentiate finishing processes, know their capabilities and applications

4) Differentiate different non-traditional machining processes based on the mechanism of material removal, working principle and analyze the process parameters of ECM, EDM, WEDM and USM.

5) Select different forging processes, machines, knowledge of die design parameters,. Analyze and calculate the forging pressure and load in open die forging and identify forging defects.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1
5	3	3	3	1	3	1	1	1	1	1	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2017-18 ACADEMIC YEAR: 2018-19
SEMESTER : FOURTH

COURSE TITLE: MATERIAL SCIENCE AND METALLURGY		
Sub Code: ME45	**No of Credits : L-T-P-SS 3:0:0:0 =3**	**No. of lecture hours/week : 03**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Engineering physics**	

Course objectives:

1. Know the fundamental science and engineering principles relevant to engineering materials.
2. Understand the intricacies involved in characterization, processing and design of materials.
3. Have the necessary theoretical and experimental skills for a pursuit in professional career.
4. Possess an intrinsic knowledge of the significance of different materials, the value of continued learning and environmental / social issues surrounding materials.
5. The student should be able to understand all basic principles involved in the application of materials for different engineering sectors.

#	CONTENTS	HOUR
Unit No.1	**CRYSTAL STRUCTURES, MECHANICAL BEHAVIOUR AND PLASTIC DEFORMATION**	**05**
	Introduction to types of crystal structures, imperfection in solids, diffusion, stress-strain diagram showing ductile and brittle behaviour of materials, linear and nonlinear elastic behaviour and properties, mechanical properties in plastic region, yield strength, offset yield strength, ductility, malleability, ultimate tensile strength, toughness. Plastic deformation of single crystal by slip and twinning, strain hardening and strain aging.	
Unit No.2	**FRACTURE,CREEP AND FATIGUE**	**06**
	Types of fracture, Griffith criteria for brittle fracture, distinguishing features of brittle and ductile fracture. Three stages of creep deformation and creep properties. Types of fatigue loading with examples, mechanism of fatigue, fatigue properties, fatigue testing and SN diagram.	
Unit No.3	**SOLIDIFICATION**	**06**
	Mechanism of solidification, homogenous and heterogeneous nucleation, crystal growth, cast metal structures. Solid solutions Hume Rothary rule, substitutional and interstitial solid solutions, intermediate phases and Gibbs phase rule.	
Unit No.4	**PHASE DIAGRAM AND HEAT TREATMENT**	**11**
	PHASE DIAGRAM: Types of phase diagrams, construction of equilibrium diagrams involving complete and partial solubility, lever rule, iron carbon equilibrium diagram, description of phases, solidification of steels and a cast irons and invariant reaction. **HEAT TREATMENT:** TTT curves, continuous cooling curves (CCT), Annealing and its types, normalizing, hardening, tempering, martempering, austempering, hardenability, surface hardening methods like carburizing, cyaniding, nitriding, flame hardening and induction hardening, age	

	hardening of aluminium-copper alloys.	
Unit No.5	**FERROUS, NON-FERROUS, COMPOSITE AND SMART MATERIALS**	**11**
	Steel and its classification, Properties, Composition and uses of Grey cast iron, malleable iron, Spheroidal Graphite iron; Copper alloys-brasses and bronzes; Aluminium alloys-Al-Cu, Al-Si, Al-Zn alloys. General aspects, classification, properties, uses, characteristics, applications of composite materials, types of matrix materials & reinforcements, disadvantages, advantages and application of composites. Introduction and properties of piezoelectric materials, shape memory alloys, ER and MR fluids, electrostrictive and magnetostrictive materials as smart materials, applications.	

TEXT BOOKS:

1. Foundations of Materials Science and Engineering, Smith, 3rdEditionMcGraw Hill, 2009
2. Materials Science, Shackleford and M. K. Muralidhara, Pearson Publication –2007.
3. Material Science, by Callister, Reprint 2008, Wiley India (P) LTD.
4. Material Science by V. Raghavan, Fifth Edition, PHI(P) LTD.
5. Smart Material and Structures by M.V. Gandhi and B.S. Thompson, First Edition 1992, Chapman& Hall.
6. Introduction to physical metallurgy by Avner S H, 2nd Ed., MHP, 1985

REFERENCE BOOKS:

1. Elements of Materials Science and Engineering, H. Van Vlack
2. Engineering Materials Science, W.C. Richards, PHI, 1965.
3. Physical Metallurgy; Lakhtin, Mir Publications.
4. Material Science and Engineering (SI Units), R.K. Rajput
5. Smart Materials and Structures, M V Gandhi and B S Thompson Chapmen &Hall
6. Physical metallurgy: principles and practice, V. Raghavan,
7. Material science and Metallurgy by K R Phaneesh, Sudha Publications-2005

REMINDER

BREAK-UP OF COURSE CONTENTS FOR
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (50%)
CIE-3: UNIT 4 (50%) + UNIT 5 (100%)
(Irrespective of portions covered due to whatever might be the reason)

QUESTION PAPER PATTERN (SEE)

#	Q1	Q2	Q3	Q4	Q5	Q6	Q7
UNIT	1	2	3	4		5	

SCHEME OF EXAMINATION (SEE) (Question Paper Pattern)

1. Students shall answer Q1, Q2 and Q3 from Unit1, Unit 2 and Unit 3 respectively without choice.
2. Students shall answer Q4 or Q5 from Unit 4 and Q6 or Q7 from Unit5.
3. Each question shall contain maximum of 3 subdivisions.

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Understand the scientific and engineering principles underlying the major phenomenon in the field of Metallurgical and Materials Engineering, namely structure, defects, properties, processing, performance, specimen preparation and characterization related to materials systems appropriate to the field.
2. Design and conduct experiments as per ASTM standards and analyze the acquired data. Types of fracture and the governing factors for creep and fatigue.
3. Analyse microstructural details, chemical composition, nucleation, grain growth and phase morphology evolution and their relation to physical, chemical and mechanical properties.
4. Develop a capability to read a binary phase diagram and predict the microstructures that can be obtained by suitable heat treatment.
5. Know the different characteristics of ferrous and non-ferrous materials and their applicability for different applications and also know the physical and mechanical properties of new engineering materials like composite and smart materials.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	3	1	1	1	2	1	1	1	2
3	3	3	3	2	2	1	1	1	2	1	1	1
4	3	3	3	1	2	1	1	1	1	2	1	2
5	3	3	2	2	1	1	1	1	2	1	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2017-18 ACADEMIC YEAR: 2018-19
SEMESTER : FOURTH

COURSE TITLE : MATERIAL TESTING LABORATORY		
Sub Code: MEL46	**No of Credits : L-T-P-SS 0:0:2:0 = 1**	**No. of lecture hours/week : 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 50**
Pre-requisites	**Material science and metallurgy**	

COURSE OBJECTIVES:

1) To focus on the standards to be followed for mechanical properties estimation
2) To understand the need for the methods of mechanical properties testing
3) To know the salient steps in preparing test coupons for microstructure study
4) To get a peek into the non-destructive testing.

#	Contents	Hrs
PART A	**INTRODUCTION TO ASTM STANDARDS FOR TESTING OF MATERIALS**	**16**
	Tensile, shear and compression tests of metallic and non-metallic specimens using Universal Testing Machine, Torsion Test, Bending Test on metallic and nonmetallic specimens, Fatigue Test, Izod and Charpy Tests on M.S,C.I Specimen, Brinell, Rockwell and Vickers's Hardness test. Shear test (double shear)	
PART B	**PREPARATION OF SPECIMEN FOR METALLOGRAPHIC EXAMINATION OF DIFFERENT ENGINEERING MATERIALS**	**08**
	Identification of microstructures and grain size count of plain carbon steel, tool steel, gray C.I, SG iron, Brass and Bronze & composites. To study the defects of Cast and Welded specimens using Non-destructive test experiments like, (a) Ultrasonic flaw detection (b) Magnetic crack detection (c) Dye penetration testing equipment, microstructure studies of composites.	

REFERENCE BOOKS:

1.“Mechanical Metallurgy”**, George E Dieter, Mc Graw Hill Publications, 1986.**
2.“Strength of Materials”, **S.S. Rathan, Tata McGraw Hill Publications, Second Edition**

CONTINUOUS INTERNAL EVALUATION (CIE)

1. CIE has a maximum of 50 marks i.e., Evaluation of Record (30) + Test (20)
2. CIE Marks is finalized by conducting ONE test at the end of 10^{th} week of the semester.

SCHEME OF EXAMINATION (SEE):

ONE question from Part A	:	25 Marks
ONE question from Part B	:	15 Marks
Viva-Voce	:	10 Marks
Total	:	50 Marks

COURSE OUTCOMES: On completion of the course, student should be able to;

1) Familiarize with the standards for mechanical properties estimation
2) Validate the need for mechanical properties testing
3) Conversant with preparing test coupons for microstructure study
4) Acquaint with non-destructive testing

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	1	2	1	1	1	1	2	1	1
2	3	3	2	1	1	1	1	1	1	1	1	1
3	3	3	3	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	2	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2017-18 ACADEMIC YEAR: 2018-19
SEMESTER : FOURTH

COURSE TITLE : MANUFACTURING PROCESS LABORATORY - II		
Sub Code: MEL47	**No of Credits : L-T-P-SS 0:0:2:0 = 1**	**No. of lecture hours/week : 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 50**
Pre-requisites	**Manufacturing process - I**	

COURSE OBJECTIVES:

1. To teach the students to produce simple work pieces using different machines such as lathe, shaping, milling and drilling.

#	CONTENTS	Hrs
PART A	**TURNING MACHINE**	**14**
	Preparation of three models on lathe involving Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning.	
PART B	**SHAPING and MILLING MACHINE**	**10**
	Cutting of V Groove / dovetail / Rectangular groove using a shaper / milling machine Cutting of Gear Teeth using Milling Machine.	

REFERENCE BOOKS:

1. **Production Technology,** R.K.Jain, Khanna Publications, 2003.
2. **Production Technology,** HMT, Tata McGraw Hill, 2001.
3. Manufacturing Technology - Vol. 2, P N Rao,TMH; Third edition (1 May 2013)
4. **Production Technology,** R.K.Jain, Khanna Publications, 2003.
5. Production Technology, P.C. Sharma, S Chand (1 December 2006)

CONTINUOUS INTERNAL EVALUATION (CIE)

4.CIE has a maximum of 50 marks.
5.CIE Marks is finalized by conducting a test at the end of 10^{th} week of the semester.
6.CIE Marks (50) = Evaluation of Record (30) + Test (20)

SCHEME OF EXAMINATION (SEE):

1.One Compulsory Model from PART A: 20 marks
2.One optional Model from unit PART B: 20 marks
3.Viva – Voce 10 marks

TOTAL 50 marks

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Identify machines and usage of machine tools.
2. Demonstrate setting of work piece into different machines.
3. Analyze and utilize tools in machining different workpieces and then with care to load and unload workpieces as per the set dimensions.
4. Able to carry out different operations on lathe, milling, drilling and shaping machines.

ADMISSION YEAR : 2017-18 **ACADEMIC YEAR: 2018-19**
SEMESTER : FOURTH

COURSE TITLE : FLUID MECHANICS AND MACHINES LABORATORY		
Sub Code: MEL48	**No of Credits : L-T-P-SS 0:0:2:0 = 1**	**No. of lecture hours/week : 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 50**
Pre-requisites	**Fluid mechanics, turbo machines**	

Course objectives:
1. To conduct experiment to determine coefficient of impact of water jet on vanes.
2. To determine coefficient of discharge of orifice meter, venturimeter and V-notch.
3. To conduct experiment to determine minor and major loss of head in flow through a pipe.
4. To conduct performance test on Pelton, Francis and Kaplan turbines and evaluate the efficiency of these turbines.
5. To determine the efficiency of single stage and multi stage centrifugal pump and plot.
6. To conduct performance test on reciprocating pump and determine the percent-age slip.

#	CONTENTS	Hrs
PART A	**MINOR EXPERIMENT**	**12**
	1. Impact of jet on vanes - Determination of coefficient of impact of water jet on flat vane, inclined vane and hemispherical vane. 2. Orifice meter – Determination of coefficient of discharge (Calibration of orifice meter) 3. Venturimeter – Determination of coefficient of discharge (Calibration of venturimeter) 4. V- notch – Determination of coefficient of discharge (Calibration of V notch). 5. Flow through a pipe - Determination of major losses.	
PART B	**MAJOR EXPERIMENT**	**12**
	I. Performance testing, plotting the characteristic curves and determination of unit quantities and specific speed of 1) Pelton turbine 2) Francis turbine 3) Kaplan turbine II. Performance testing, plotting the characteristic curves and determination of specific speed of 4) Single stage centrifugal pump 5) Multi stage centrifugal pump III. Coefficient of discharge and percentage slip of a 6) Reciprocating pump	

SCHEME OF EXAMINATION (SEE)

Sl. No.	Particulars	Max. Marks	Break Up of Max. Marks		
			Write Up	Conduction of experiment	Specimen Calculation, Tabulation of Results and Plotting of Graph
1	**Unit-1: Minor Experiment** (Any ONE from the list of experiments)	**15**	05	05	05
2	**Unit-2: Major Experiment** (Any ONE from the list of experiments)	**25**	05	10	10
3	Viva Voce	**10**	--	--	--
	TOTAL MARKS	**50**	**10**	**25**	**15**

REFERENCE BOOKS:

1) Hydraulics and Fluid Mechanics including Hydraulic Machines, Dr. P.N. Modi and S.M. Seth, Rajsons Publications Private Limited, Standard Book House, 2009.

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Describe fluid properties and classify them.
2. Calibrate different types of flow measurement devices.
3. Understand the general working of fluid machines.
4. Describe the functioning of radial flow and axial flow fluid machines.
5. Derive various equations related to the performance of turbo machines.
6. Analyze and predict the performance of various turbo machines.

MAPPING OF COs WITH POs

COs/POs	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	2	1	2	1	1	1	1	2	1	1
2	3	3	3	1	2	1	1	1	1	1	1	1
3	3	3	2	1	2	1	1	1	1	2	1	1
4	3	3	2	1	2	1	1	1	1	3	1	1
5	3	3	3	1	2	1	1	1	1	1	1	1
6	3	3	3	1	3	1	1	1	1	3	1	1

Strong-3, Medium-2, Weak-1

ADMISSION YEAR : 2019-20 ACADEMIC YEAR: 2019-20
SEMESTER : FIRST / SECOND

COURSE TITLE : ELEMENTS OF MECHANICAL ENGINEERING		
Sub Code: 18ME15 / 25	**No of Credits : L-T-P-SS 2:2:0:0 =3**	**No. of contact hours/week : 04**
Exam Duration : 3 hours	**Exam Marks : 100 CIE: 50**	**Total No. of hours : 52**
Pre-requisites	**Physics, Chemistry**	

COURSE OBJECTIVES:

1. Knowledge on importance of steam and its properties.
2. Overview on water, steam and gas turbines. Internal combustion engine's performance.
3. Permanent metal joining processes and their applications.
4. Understanding of manufacturing process, turning machine with emphasis on importance on metal cutting and power transmission.

#	CONTENTS	Hrs.
UNIT-1	**ENERGY, STEAM AND TURBINES**	**10**
	Energy – conventional and non-conventional energy sources and their comparison **Steam -**Steam formation at a constant pressure; properties of steam, simple numerical problems to understand the use of steam tables, Introduction to Boilers **Turbines -** Introduction, construction and working of reaction & impulse steam turbines, construction & working of open & closed cycle gas turbines, construction and working of Pelton wheel, Kaplan and Francis water turbines. Principles of pumps and valves.	
UNIT-2	**I C ENGINES, REFRIGERATION AND AIR CONDITIONING**	**16**
	Internal combustion engines - Introduction, classification of I.C engines, parts of an I.C engine, I.C engine terminology, introduction to2-stroke petrol engines, construction and working principles of 4-stroke petrol & diesel engines, simple numerical problems (four stroke) on indicated power, brake power, mechanical efficiency, indicated and brake thermal efficiency (demonstration of working of I.C engines), introduction to MPFI engines. **Refrigeration and Air conditioning -** Introduction, definition of refrigeration, concepts of refrigeration, parts of a refrigerator, refrigeration terminology, types of refrigeration systems, comparison between VAR and VCR, commonly used refrigerants and their properties. Principles & working of room air conditioner, central air conditioning.	
UNIT-3	**METAL JOINING AND MANUFACTURING PROCESSES**	**10**
	Soldering - working principle and applications; types of solder; sketch and description of soldering iron method. **Brazing -** Working principle and methods of brazing; Comparison of soldering and brazing. **Welding -**introduction and applications of welding; classification; sketch and description of electric arc welding. Sketch and description of oxy-acetylene gas welding; comparison of welding, soldering and brazing processes. Principles of casting, forging and powder metallurgy.	
UNIT-4	**TURNING MACHINE AND POWER TRANSMISSION**	**16**
	Turning machine - Working principle, specification of center lathe, sketch and description of operations performed – turning, facing, knurling, thread cutting, drilling, taper turning and boring; demonstration of operations in machine shop. **Power transmission -** Introduction; Belt drives – types of belts, types of belt drive;	

	terminology - velocity ratio, creep and slip. **Gear drives** - Introduction, classification; gear trains – introduction; types of gear train; simple numerical problems on gear drives.	

TEXT BOOK:

1. Elements of Mechanical Engineering - K.R. Gopalkrishna, Subhash publishers, Bangalore.

REFERENCE BOOK:

1. Elements of Workshop Technology. Vol 1 & 2, S.K.H. Chowdhary, A.K.H. Chowdhary and Nirjhar Roy, 11^{th} edition 2001, Media Promoters and Publishers, Mumbai.
2. Hand books of Mechanical Engineering

COURSE OUTCOMES: On completion of the course, student should be able to;

CO1: Evaluate the performance of various power generation machines like steam, gas and hydraulic turbines, I.C engines, and power absorbing devices such as refrigeration and air conditioning.

CO2: To know the principle, application of various metal joining and manufacturing processes.

CO3: Describe the working principles and applications of various machine tools.

CO4: Choose appropriate power transmission methods for various applications.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	2	1	1	1	1	2	1	1
CO2	3	3	2	1	2	1	1	1	1	2	1	1
CO3	3	3	2	1	2	1	1	1	1	2	1	1
CO4	3	3	2	1	2	1	1	1	1	2	1	1
Strong-3, Medium-2, Weak-1												

SCHEME OF EXAMINATION (SEE)

1. **COMPULSORY** objective multiple choice questions for 20 marks (Q.1) covering all the FOUR units. It should contain 20 questions of 1 mark each.
2. Two FULL questions from Unit-1 with choice (Q2 **OR** Q.3).
3. Two FULL questions from Unit-2 with choice (Q.4 **OR** Q.5).
4. Two FULL questions from Unit-3 with choice (Q.6 **OR** Q.7)
5. Two FULL questions from Unit-4 with choice (Q.8 **OR** Q.9).
6. Each FULL question carries 20 marks.
7. Answers are to be supported with schematic diagrams/sketches wherever necessary.
8. Each full question shall contain maximum of 3 subdivisions (Q2-Q9).

ADMISSION YEAR : 2019-20 ACADEMIC YEAR: 2019-20
SEMESTER : FIRST / SECOND

COURSE TITLE : COMPUTER AIDED ENGINEERING DRAWING		
Sub Code: 18MEL15 / 25	**No of Credits : L-T-P-SS 0:2:2:0 =3**	**No. of contact hours/week : 04**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Mathematics - Geometry**	**Total No. of hours: 52**

COURSE OBJECTIVES:

1. To make the student to understand the importance of drawing in all walks of life.
2. To give basics of different views of an object and practice principal planes projections
3. To make him understand different orientations of lines, planes and solids.
4. Give the concept of Isometric view of simple objects.

#	CONTENTS	Hrs
UNIT-1	**INTRODUCTION TO ENGINEERING DRAWING**	**08**
	BASICS: History of engineering drawing, Introduction to drawing instruments and their uses, understanding and drawing reducing, enlarging and same scales, different drawing sheet sizes, Different type of lines used in engineering drawing, Introduction to Lettering, Construction of Regular Polygons and Dimensioning. **ORTHOGRAPHIC PROJECTIONS OF POINTS:** Introduction to Orthographic projections, Principal views and Principal Planes [VP, HP, LPP & RPP], Four Quadrants and system of projection, Orthographic projections of points, Location of point in first quadrant.	
UNIT-2	**ORTHOGRAPHIC PROJECTION OF STRAIGHT LINE [FIRST ANGLE]**	**08**
	Definition of a Straight line, Projection of line, Position of line with respect to HP, VP & PP: i) Parallel to both planes, ii) Parallel to one plane and perpendicular to the other, iii) Parallel to one plane and inclined to other, iv) Inclined to both planes. True length and Apparent Length, True Inclination and Apparent Inclination, End projector distance.	
UNIT-3	**ORTHOGRAPHIC PROJECTIONS OF PLANE SURFACES [FIRST ANGLE]**	**08**
	Definition of plane surfaces, Placing a plane surface, Projections of plane surface: Triangle, Square, Rectangle, Rhombus, Pentagon, Hexagon, and Circle. Planes in different positions by change of position only.	
UNIT-4	**PROJECTIONS OF SOLIDS**	**20**
	Definition of solid, Classification of solids (Polyhedron and solids of revolution). Projection of triangular, square, rectangular and hexagonal prisms and pyramids, tetrahedron, projection of cone and cylinder in different positions.	
UNIT-5	**ISOMETRIC PROJECTION**	**08**
	Introduction, Isometric scales, Isometric projections of Regular Polygons, Isometric Projection of prisms, pyramids, cylinders, cones, sphere, hemisphere, tetrahedron, hexahedron/cube and combination of **any two full** solids or combination of **one full** and **one frustum** of one solids. Demonstration of basic machine parts	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Draw views of points, lines and planes in any orientation.
2. Draw views of simple solids resting in different positions.

3. Visualize the building / machine yet to be built / manufactured.

TEXT BOOKS:

1. Engineering Graphics – K.R. Gopalakrishna, 32^{nd} Edition, 2005
2. Engineering Drawing – N.D. Bhatt and V.M. Panchal, 4^{8th} Edition, 2005

REFERENCE BOOKS:

1. Computer Aided Engineering Drawing – S. Trymbaka Murthy, 3^{rd} Revised Ed, 2006.
2. Fundamentals of Engineering Drawing with an Introduction to Interactive Computer Graphics for Design and Production – J. Luzadder Warren, M. Duff John, 2005
3. A Primer on Computer Aided Engineering Drawing – 2006.

CONTINUOUS INTERNAL EVALUATION (CIE):

1. Solve class work problems manually using pencil, scale and other geometry instruments on A4 drawing sheets and submit them to the staff-in-charge, and only after the students are allowed to do in computer drafting.
2. All the solutions must be valued on the spot by examining the manual sketches, computer display and hard copies.
3. All the sketches including the computer print outs must be submitted in a bound form for Continuous Internal Evaluation and they must be preserved for one year by the concerned Department.
4. Break-up of marks for CIE:

➢ Manual Sketching	-	25 Marks
➢ Computer Drafting	-	15 Marks
➢ Test	-	10 Marks
Total	**-**	**50 Marks**

SCHEME OF EXAMINATION FOR SEE:		
Q. No.	**CHAPTERS**	**Marks**
Q1 (a)	Orthographic projection of points	**05**
(b)	Orthographic projection of Lines	**10**
Q2	Projection of Planes	**15**
Q3 & Q4	Projection of solids **[2 question's with Choice]**	**20**
Q5 & Q6	Isometric projection **[2 question's with Choice]**	**15**
TOTAL		**50**

1. Note: Six Full Questions are to be set.
2. Three full Questions are to be answered with a choice as Q1 or Q2; Q3 or Q4 and Q5 or Q6.
3. Both manual sketching and computer printout are necessary for all questions.
4. 40% of marks is for manual sketching and 60% is for computer print outs.

I SEMESTER Bachelor of Engineering
Three week long mandatory non- credit Induction Program For the UG students entering the institution, right at the start. Normal classes start only after the Induction program is completed.

Preamble:

- Engineering institutions are set up to generate well trained manpower in engineering with a feeling of responsibility towards oneself, one's family, and society.
- However, often, the incoming undergraduate students are driven by their parents and society to join engineering without understanding their own interests and talents.
- As a result, most students fail to link up with the goals of their own institution.
- Students, who enter an institution, will have come with diverse thoughts, backgrounds and preparations.
- It is important to help them adjust to the new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large and nature, and inculcate in them the ethos of the institution with a sense of larger purpose.
- The graduating student must have knowledge and skills in the area of his study.
- Character needs to be nurtured as an essential quality by which he/she would understand and full his/her responsibility as an engineer, a citizen and a human being.
- Besides the above, several meta-skills and underlying values are needed.

Therefore, a Program is needed to

- Help the newly joined students feel comfortable,
- Sensitize them towards exploring their academic interests and activities,
- Train them to work for excellence,
- Build relations between teachers and students,
- Impart a broader view of life,
- Build character,
- Develop awareness and sensitivity to human values,
- Create feeling of equality, compassion and oneness,
- Develop attention to society and nature.

An induction program for the UG students entering the institution, right at the start, serves the purpose.

- The program also makes them reflect on their relationship with their families and extended family in the college (with hostel staff and others).

- It also connects students with each other and with teachers so that they can share any difficulty they might be facing and seek help.
- The Induction Program can also be used to rectify some critical lacunas, for example, English background, for those students who have deficiency in it.

Activities of the induction program

- Induction program includes Physical Activity, Creative Arts, Universal Human Values, Literary, Proficiency Modules, Lectures by Eminent People, Visits to Local Area, Familiarization to Department / Branch and Innovations, etc.
- For more details refer to “A Guide to Induction Program”, Page – 31, Model Curriculum for Undergraduate Degree Courses in Engineering and Technology, January 2018, Volume I.

I SEMESTER B.E (PHYSICS GROUP)														
#	Course and Course Code		Course Title	Teaching Department	Paper Setting Board	Teaching Hours /Week			Examination					Credits
						Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks		
						L	T	P						
1	BC	18MA11	Calculus and Linear Algebra	Mathematics	Science	3	2	--	3	50	50	100		4
2	BC	18PH12	Engineering Physics	Physics	Science	3	2	--	3	50	50	100		4
3	ES	18EE13	Basic Electrical Engineering	E and E Engineering	E and E Engineering	2	2	--	3	50	50	100		3
4	ES	18CV14	Civil Engineering and Mechanics	Civil Engineering	Civil Engineering	2	2	--	3	50	50	100		3
5	ES	18MEL15	Computer Aided Engineering Drawing	ME	Mechanical Engineering	2	--	2	3	50	50	100		3
6	BC	18PHL16	Engineering Physics Laboratory	Physics	Science	--	--	2	3	50	50	100		1
7	ES	18EEL17	Basic Electrical Engineering Laboratory	E and E Engineering	E and E Engineering	--	--	2	3	50	50	100		1
8	HS	18HS11/ 18HS12	English / Kannada	Humanities	Humanities	1	--	2	2	50	50	100		1
9	HS	18HS13	Career Development Skills	Humanities	Humanities	2	--	--	2	50	--	50		--
					TOTAL	**15**	**8**	**8**	**25**	**450**	**400**	**850**		**20**

I SEMESTER B.E (CHEMISTRY GROUP)

#	Course and Course Code		Course Title	Teaching Department	Paper Setting Board	Teaching Hours /Week			Examination				Credits
						Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
						L	T	P					
1	BC	18MA11	Calculus and Linear Algebra	Mathematics	Science	3	2	--	3	50	50	100	4
2	BC	18CH12	Engineering Chemistry	Chemistry	Science	3	2	--	3	50	50	100	4
3	ES	18CS13	C Programming for Problem Solving	CSE	CSE	2	2	--	3	50	50	100	3
4	ES	18EC14	Basic Electronics	EC/E and I/ TE	E and C	2	2	--	3	50	50	100	3
5	ES	18ME15	Elements of Mechanical Engineering	ME	Mechanical Engineering	2	2	--	3	50	50	100	3
6	BC	18CHEL16	Engineering Chemistry Laboratory	Chemistry	Science	--	--	2	3	50	50	100	1
7	ES	18CSL17	Computer Programming Laboratory	CSE	CSE	--	--	2	3	50	50	100	1
8	HS	18HS11/ 18HS12	English / Kannada	Humanities	Humanities	1	--	2	2	50	50	100	1
9	HS	18HS13	Career Development Skills	Humanities	Humanities	2	--	--	2	50	--	50	--
					TOTAL	**15**	**10**	**06**	**23**	**450**	**400**	**850**	**20**

II SEMESTER B.E (PHYSICS GROUP)

#	Course and Course Code		Course Title	Teaching Department	Paper Setting Board	Teaching Hours /Week			Examination				Credits
						Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
						L	T	P					
1	BC	18MA21	Differential Equations and Complex Variables	Mathematics	Science	3	2	--	3	50	50	100	4
2	BC	18PH22	Engineering Physics	Physics	Science	3	2	--	3	50	50	100	4
3	ES	18EE23	Basic Electrical Engineering	E and E	E and E	2	2		3	50	50	100	3
4	ES	18CV24	Civil Engineering and Mechanics	Civil	Civil	2	2	--	3	50	50	100	3
5	ES	18MEL25	Computer Aided Engineering Drawing	Mechanical	Mechanical	2		2	3	50	50	100	3
6	BC	18PHL26	Engineering Physics Laboratory	Physics	Science	--	--	2	3	50	50	100	1
7	ES	18EEL27	Basic Electrical Engineering Laboratory	E and E	E and E	--	--	2	3	50	50	100	1
8	HS	18HS21/ 18HS22	English / Kannada	Humanities	Humanities	1	--	2	2	50	50	100	1
9	HS	18HS23	Soft Skills	Humanities	Humanities	2	--	--	2	50	--	50	--
					TOTAL	**15**	**8**	**8**	**25**	**450**	**400**	**850**	**20**

Note: BC: Science Course, ES: Engineering Science, Hu: Humanity and Social Science.	
Definition of Credit:	1 hour Lecture (L) per week per semester =1 Credit 2 hour Tutorial (T) per week per semester =1 Credit 2 hour Practical/Laboratory/Drawing (P) per week per semester =1 Credit.

II SEMESTER B.E (CHEMISTRY GROUP)														
#	Course and Course Code		Course Title	Teaching Department	Paper Setting Board	Teaching Hours /Week		Examination						Credits
						Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks		
						L	T	P						
1	BC	18MA21	Differential Equations and Complex Variables	Mathematics	Science	3	2	--	03	50	50	100		4
2	BC	18CH22	Engineering Chemistry	Chemistry	Science	3	2	--	03	50	50	100		4
3	ES	18CS23	Programming for Problem Solving	CS	CS	2	2	--	03	50	50	100		3
4	ES	18ELN24	Basic Electronics	EC/EI/ TE	E and C	2	2	--	03	50	50	100		3
5	ES	18ME25	Elements of Mechanical Engineering	Mechanical	Mechanical	2	2	--	03	50	50	100		3
6	BC	18CHL26	Engineering Chemistry Laboratory	Chemistry	Science	--	--	2	03	50	50	100		1
7	ES	18CSL27	Computer Programming Laboratory	CS	CS	--	--	2	03	50	50	100		1
8	HU	18HS21/ 18HS22	English / Kannada	Humanities	Humanities	1	--	2	2	50	50	100		1
9	HS	18HS23	Soft Skills	Humanities	Humanities	2	--	--	2	50	--	50		--
					TOTAL	**15**	**10**	**6**	**25**	**450**	**400**	**850**		**20**

Note: BS: Science Course, ES: Engineering Science, Hu: Humanity and Social Science.	
Definition of Credit:	1 hour Lecture (L) / week / semester =1 Credit ; 2 hour Tutorial (T) per week per semester =1 Credit ; 2 hour Practical/Laboratory/Drawing (P) per week per semester =1 Credit.

ADMISSION YEAR : 2020-21 ACADEMIC YEAR: 2020-21
SEMESTER : FIRST / SECOND

COURSE TITLE : ELEMENTS OF MECHANICAL ENGINEERING		
Sub Code: 18ME15 / 25	**No of Credits : L-T-P-SS 2:2:0:0 =3**	**No. of contact hours/week : 04**
Exam Duration : 3 hours	**Exam Marks : 100 CIE: 50**	**Total No. of hours : 52**
Pre-requisites	**Physics, Chemistry**	

COURSE OBJECTIVES:

1. Knowledge on importance of steam and its properties.
2. Overview on water, steam and gas turbines. Internal combustion engine's performance.
3. Permanent metal joining processes and their applications.
4. Understanding of manufacturing process, turning machine with emphasis on importance on metal cutting and power transmission.

#	CONTENTS	Hrs.
UNIT-1	**ENERGY, STEAM AND TURBINES** (CLASS ROOM TEACHING)	**10**
	Energy – conventional and non-conventional energy sources and their comparison **Steam -**Steam formation at a constant pressure; properties of steam, simple numerical problems to understand the use of steam tables, Introduction to Boilers **Turbines -** Introduction, construction and working of reaction & impulse steam turbines, construction & working of open & closed cycle gas turbines, construction and working of Pelton wheel, Kaplan and Francis water turbines. Principles of pumps and valves. **(OFFLINE MODE)**	
UNIT-2	**I C ENGINES, REFRIGERATION AND AIR CONDITIONING** (BLENDED TEACHING)	**16**
	Internal combustion engines - Introduction, classification of I.C engines, parts of an I.C engine, I.C engine terminology, introduction to2-stroke petrol engines, construction and working principles of 4-stroke petrol & diesel engines, simple numerical problems (four stroke) on indicated power, brake power, mechanical efficiency, indicated and brake thermal efficiency (demonstration of working of I.C engines), introduction to MPFI engines. **Refrigeration and Air conditioning -** Introduction, definition of refrigeration, concepts of refrigeration, parts of a refrigerator, refrigeration terminology, types of refrigeration systems, comparison between VAR and VCR, commonly used refrigerants and their properties. Principles & working of room air conditioner, central air conditioning.	
UNIT-3	**METAL JOINING AND MANUFACTURING PROCESSES** (BLENDED TEACHING)	**10**

	Soldering - working principle and applications; types of solder; sketch and description of soldering iron method. **Brazing -** Working principle and methods of brazing; Comparison of soldering and brazing. **Welding -**introduction and applications of welding; classification; sketch and description of electric arc welding. Sketch and description of oxy-acetylene gas welding; comparison of welding, soldering and brazing processes. **Manufacturing Processes -** Principles of casting, forging and powder metallurgy.	
UNIT-4	**LATHE AND POWER TRANSMISSION** (ONLINE TEACHING)	**16**
	Lathe - Working principle, specification of center lathe, sketch and description of operations performed – turning, facing, knurling, thread cutting, drilling, taper turning and boring; demonstration of operations in machine shop. **Power transmission -** Introduction; Belt drives – types of belts, types of belt drive; terminology - velocity ratio, creep and slip, simple numerical problems. **Gear drives -** Introduction, classification; gear trains – introduction; types of gear train; simple numerical problems on gear drives.	

TEXT BOOK:

1. Elements of Mechanical Engineering - K.R. Gopalkrishna, Subhash publishers, Bangalore.

REFERENCE BOOK:

1. Elements of Workshop Technology. Vol 1 & 2, S.K.H. Chowdhary, A.K.H. Chowdhary and Nirjhar Roy, 11th edition 2001, Media Promoters and Publishers, Mumbai.
2. Hand books of Mechanical Engineering

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: To know the basics, working of various power generation devices like steam, gas and hydraulic turbines.

CO2: To study about the various IC engines, and power absorbing devices such as refrigerators and air conditioning.

CO3: To know the principle, application of various metal joining and manufacturing processes.

CO4: Describe the working principles and applications of turning machine and power transmission methods for various applications.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	1	1	1	1	2	2	1	1	1	1	3
CO2	3	2	2	1	1	2	2	1	1	1	1	3
CO3	2	1	1	1	2	2	2	1	1	1	1	3
CO4	3	1	2	1	2	2	2	1	1	1	1	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

SCHEME OF EXAMINATION (SEE)

1. **COMPULSORY** objective multiple choice questions for 20 marks (Q.1) covering all the FOUR units. It should contain 20 questions of 1 mark each.
2. Two FULL questions from Unit-1 with choice (Q2 **OR** Q.3).
3. Two FULL questions from Unit-2 with choice (Q.4 **OR** Q.5).
4. Two FULL questions from Unit-3 with choice (Q.6 **OR** Q.7)
5. Two FULL questions from Unit-4 with choice (Q.8 **OR** Q.9).
6. Each FULL question carries 20 marks.
7. Answers are to be supported with schematic diagrams/sketches wherever necessary.
8. Each full question shall contain maximum of 3 subdivisions (Q2-Q9).

ADMISSION YEAR : 2020-21 ACADEMIC YEAR: 2020-21
SEMESTER : FIRST / SECOND

COURSE TITLE : COMPUTER AIDED ENGINEERING DRAWING		
Sub Code: 18MEL15 / 25	**No of Credits : L-T-P-SS 0:2:2:0 =3**	**No. of contact hours/week : 04**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Mathematics - Geometry**	**Total No. of hours: 52**

COURSE OBJECTIVES:

1. To make the student to understand the importance of drawing in all walks of life.
2. To give basics of different views of an object and practice principal planes projections
3. To make him understand different orientations of lines, planes and solids.
4. Give the concept of Isometric view of simple objects.

#	CONTENTS	Hrs
UNIT-1	**INTRODUCTION TO ENGINEERING DRAWING (**CLASSROOM TEACHING)	**08**
	BASICS: History of engineering drawing, Introduction to drawing instruments and their uses, understanding and drawing reducing, enlarging and same scales, different drawing sheet sizes, Different type of lines used in engineering drawing, Introduction to Lettering, Construction of Regular Polygons and Dimensioning. **ORTHOGRAPHIC PROJECTIONS OF POINTS:** Introduction to Orthographic projections, Principal views and Principal Planes [VP, HP, LPP & RPP], Four Quadrants and system of projection, Orthographic projections of points, Location of point in first quadrant.	
UNIT-2	**ORTHOGRAPHIC PROJECTION OF STRAIGHT LINE [FIRST ANGLE] (**CLASSROOM TEACHING)	**08**
	Definition of a Straight line, Projection of line, Position of line with respect to HP, VP & PP: i) Parallel to both planes, ii) Parallel to one plane and perpendicular to the other, iii) Parallel to one plane and inclined to other, iv) Inclined to both planes. True length and Apparent Length, True Inclination and Apparent Inclination, End projector distance.	
UNIT-3	**ORTHOGRAPHIC PROJECTIONS OF PLANE SURFACES [FIRST ANGLE]** (BLENDED TEACHING)	**08**
	Definition of plane surfaces, Placing a plane surface, Projections of plane surface: Triangle, Square, Rectangle, Rhombus, Pentagon, Hexagon, and Circle. Planes in different positions by change of position only.	
UNIT-4	**PROJECTIONS OF SOLIDS** (BLENDED TEACHING)	**20**
	Definition of solid, Classification of solids (Polyhedron and solids of revolution). Projection of triangular, square, rectangular and hexagonal prisms and pyramids, tetrahedron, projection of cone and cylinder in different positions.	
UNIT-5	**ISOMETRIC PROJECTION** (ONLINE TEACHING)	**08**
	Introduction, Isometric scales, Isometric projections of Regular Polygons, Isometric Projection of prisms, pyramids, cylinders, cones, sphere, hemisphere, tetrahedron, hexahedron/cube and combination of **any two full** solids or combination of **one full** and **one frustum** of one solids. Demonstration of basic machine parts	

COURSE OUTCOMES: On completion of the course, student should be able to;

1. Draw views of points, lines and planes in any orientation.
2. Draw views of simple solids resting in different positions.

3. Visualize the building / machine yet to be built / manufactured.

TEXT BOOKS:

1. Engineering Graphics – K.R. Gopalakrishna, 32nd Edition, 2005
2. Engineering Drawing – N.D. Bhatt and V.M. Panchal, 48th Edition, 2005

REFERENCE BOOKS:

1. Computer Aided Engineering Drawing – S. Trymbaka Murthy, 3rd Revised Ed, 2006.
2. Fundamentals of Engineering Drawing with an Introduction to Interactive Computer Graphics for Design and Production – J. Luzadder Warren, M. Duff John, 2005
3. A Primer on Computer Aided Engineering Drawing – 2006.

COURSE OUTCOMES: On completion of the course, student should be able to:
CO1: To make the student to understand the importance of drawing in all walks of life.
CO2: To give basics of different views of an object and practice principal planes projections and to make him understand different orientations of lines,
CO3: Will be able to orient the planes in different directions
CO4: Will be able to project solids in different orientations.
CO5: Give the concept of Isometric view of simple objects.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO**
CO1	3	2	2	1	2	0	1	1	2	2	0	2
CO2	3	2	2	1	2	0	1	1	2	2	0	2
CO3	3	2	2	1	2	0	1	1	2	2	0	2
CO4	3	2	2	1	2	0	1	1	2	2	0	2
CO5	3	2	2	1	2	0	1	1	2	2	0	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

CONTINUOUS INTERNAL EVALUATION (CIE):

1. Solve class work problems manually using pencil, scale and other geometry instruments on A4 drawing sheets and submit them to the staff-in-charge, and only after the students are allowed to do in computer drafting.
2. All the solutions must be valued on the spot by examining the manual sketches, computer display and hard copies.
3. All the sketches including the computer print outs must be submitted in a bound form for Continuous Internal Evaluation and they must be preserved for one year by the concerned Department.
4. Break-up of marks for CIE:

➢ Manual Sketching	-	25 Marks
➢ Computer Drafting	-	15 Marks
➢ Test	-	10 Marks
Total	**-**	**50 Marks**

SCHEME OF EXAMINATION FOR SEE:		
Q. No.	**CHAPTERS**	**Marks**
Q1 (a)	Orthographic projection of points	**05**
(b)	Orthographic projection of Lines	**10**
Q2	Projection of Planes	**15**
Q3& Q4	Projection of solids **[2 question's with Choice]**	**20**
Q5 & Q6	Isometric projection **[2 question's with Choice]**	**15**
TOTAL		**50**

1. Note: Six Full Questions are to be set.
2. Three full Questions are to be answered with a choice as Q1 or Q2; Q3 or Q4 and Q5 or Q6.
3. Both manual sketching and computer printout are necessary for all questions.
4. 40% of marks is for manual sketching and 60% is for computer print outs.

Dr. Ambedkar Institute of Technology, Bengaluru-560 056
SCHEME OF TEACHING AND EXAMINATION from Academic Year 2020-21
B.E Name of the programme
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

III SEMESTER

Sl .No	Course and Course Code		Course Title	Teaching Department	Teaching Hours / Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
01	BC	18MA31	Transforms & Boundary Value Problems	Mathematics	2	2	--	03	50	50	100	3
02	PC	18ME31	Material Science	Mechanical	3	0	--	03	50	50	100	3
03	PC	18ME32	Mechanics of Materials	Mechanical	3	2	--	03	50	50	100	4
04	PC	18ME33	Manufacturing Processes - I	Mechanical	3	0	--	03	50	50	100	3
05	PC	18ME34	Basic Thermodynamics	Mechanical	3	2	--	03	50	50	100	4
06	PC	18MEL35	Computer Aided Machine Drawing	Mechanical	2	0	2	03	50	50	100	3
07	PC	18MEL36	Manufacturing Processes Laboratory - I	Mechanical	--		2	03	50	50	100	1
08	PC	18MEL37	Material Testing Laboratory	Mechanical	--		2	03	50	50	100	1
09	PC	18MEL38	Fitting and Forging Workshop	Mechanical	--	--	2	03	50	50	100	1
10	HS	18HS31/32	Constitution of India Professional Ethics and Human Rights / Environmental Studies	Humanities	1	--	0	02	50	50	100	1
11	NC MC	18HS33	Soft Skills (MC)	Humanities	2	--	--	03	50	-	50	PP/ NP
TOTAL					**19**	**06**	**08**	**32**	**550**	**500**	**1050**	**24**

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs												
12	HS	18HS34	Placement Training	Humanities	02	--	--	03	50	-	50	PP/NP
13	MC	18MAD31	Advance Mathematics-I	Mathematics	02	01	--	03	50		50	PP/NP

Note: HODs are informed to accommodate one more laboratory in addition to the above courses if needed, without altering the total number of credits (TOTAL: 24).

(a) **The mandatory non – credit courses** Advance Mathematics I and II prescribed at III and IV semesters respectively, to lateral entry Diploma holders admitted to III semester of BE programs shall compulsorily be registered during respective semesters to complete all the formalities of the course and appear for SEE examination.

(b) **The mandatory non – credit courses** Advance Mathematics I and II, prescribed to lateral entrant Diploma holders admitted to III semester of BE programs, are to be completed to secure eligibility to VII semester. However, they are not considered for vertical progression from II year to III year of the programme but considered as head of passing along with credit courses of the programme to eligibility to VII semester.

Note: BC: Science Course, PC: Professional Core. Hu: Humanities, NCMC: Non-Credit Mandatory Course.

Dr. Ambedkar Institute of Technology, Bengaluru-560 056
SCHEME OF TEACHING AND EXAMINATION from Academic Year 2020-21
B.E Name of the programme
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

IV SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
01	BC	18MA41	Numerical Methods & Applied Statistics	Mathematics	2	2		03	50	50	100	3
02	PC	18ME41	Mechanical Measurements	Mechanical	3	0	--	03	50	50	100	3
03	PC	18ME42	Fluid Mechanics	Mechanical	3	2	--	03	50	50	100	4
04	PC	18ME43	Manufacturing Processes - II	Mechanical	3	0	--	03	50	50	100	3
05	PC	18ME44	Applied Thermodynamics	Mechanical	3	2	--	03	50	50	100	4
06	PC	18ME45	Kinematics of Machines	Mechanical	3	2	--	03	50	50	100	4
07	PC	18MEL46	Manufacturing Processes Laboratory - II	Mechanical	--	--	2	03	50	50	100	1
08	PC	18MEL47	Mechanical Measurements Laboratory	Mechanical	--	--	2	03	50	50	100	1
09	HS	18HS41/42	Constitution of India Professional Ethics and Human Rights / Environmental Studies	Hum/Civil	1	--	--	02	50	50	100	1
10	NC MC	18HS43	Employability Skills (MC)	Humanities	2	--	--	03	50	-	50	PP/ NP
				TOTAL	**20**	**08**	**04**	**29**	**500**	**450**	**950**	**24**

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs

11	HS	18HS44	Placement Training	Humanities	02	--	--	03	50	-	50	PP/ NP
12	MC	18MAD41	Advance Mathematics-II	Mathematics	02	01	--	03	50		50	PP/ NP

Note: HODs are informed to accommodate one more laboratory in addition to the above courses if needed, without altering the total number of credits (TOTAL: 24).

(a) The mandatory non – credit courses Advance Mathematics I and II prescribed at III and IV semesters respectively, to lateral entry Diploma holders admitted to III semester of BE programs shall compulsorily be registered during respective semesters to complete all the formalities of the course and appear for SEE examination.

(b) **The mandatory non – credit courses** Advance Mathematics I and II, prescribed to lateral entrant Diploma holders admitted to III semester of BE programs, are to be completed to secure eligibility to VII semester. However, they are not considered for vertical progression from II year to III year of the programme but considered as head of passing along with credit courses of the programme to eligibility to VII semester.

Note: BC: Science Course, PC: Professional Core. Hu: Humanities, MC: Mandatory Course.
ENV: Environmental Studies, CIP: Constitution of India Professional Ethics and Human Rights

ADMISSION YEAR : 2019-20 ACADEMIC YEAR: 2020-21
SEMESTER : THIRD

COURSE TITLE: MATERIAL SCIENCE		
Sub Code:18ME31	**No of Credits =3** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks : 50**	**Exam Marks : 100**
Pre-requisites	**Engineering Physics & Chemistry**	

COURSE OBJECTIVES:

1. Know the fundamental science and engineering principles relevant to engineering materials.
2. Understand the intricacies involved in characterization, processing and design of materials.
3. Have the necessary theoretical and experimental skills for a pursuit in professional career.
4. Possess an intrinsic knowledge of the significance of different materials, the value of continued learning and environmental / social issues surrounding materials.
5. The student should be able to understand all basic principles involved in the application of materials for different engineering sectors.

#	CONTENTS	Hrs.
UNIT 1	**CRYSTAL STRUCTURES, MECHANICAL BEHAVIOUR AND PLASTIC DEFORMATION** (CLASSROOM TEACHING)	**08**
	Introduction to types of crystal structures, imperfection in solids, diffusion, stress-strain diagram showing ductile and brittle behaviour of materials, linear and nonlinear elastic behaviour and properties, mechanical properties in plastic region, yield strength, offset yield strength, ductility, malleability, ultimate tensile strength, toughness. Plastic deformation of single crystal by slip and twinning, strain hardening and strain aging, simple problems on stress and strain.	
UNIT 2	**FRACTURE, CREEP AND FATIGUE** (CLASSROOM TEACHING)	**07**
	Types of fracture, Griffith criteria for brittle fracture, distinguishing features of brittle and ductile fracture. Three stages of creep deformation and creep properties. Types of fatigue loading with examples, mechanism of fatigue, fatigue properties, fatigue testing and SN diagram.	
UNIT 3	**SOLIDIFICATION AND PHASE DIAGRAMS** (CLASSROOM TEACHING)	**08**
	Mechanism of solidification, homogenous and heterogeneous nucleation, crystal growth, cast metal structures. Solid solutions Hume Rothary rule, substitutional and interstitial solid solutions, intermediate phases and Gibbs phase rule. Types of phase diagrams, construction of equilibrium diagrams involving complete and partial solubility, lever rule, and simple problems on phase diagrams. Iron carbon equilibrium diagram, description of phases.	
UNIT 4	**HEAT TREATMENT AND FERROUS ALLOYS** (BLENDED TEACHING)	**08**
	TTT curves, continuous cooling curves (CCT), Annealing and its types, normalizing, hardening, tempering, martempering, austempering, hardenability, surface hardening methods like carburizing, cyaniding, nitriding, flame hardening and induction hardening. Steel and its classification, properties, composition and applications of Grey cast iron, malleable iron.	
UNIT 5	**NON-FERROUS ALLOYS AND COMPOSITE MATERIALS**	**08**

	(ONLINE TEACHING)	
	Copper alloys-brasses and bronzes; Aluminum alloys-Al-Cu, Al-Si, Al-Zn alloys; **Composite materials:** classification, properties, characteristics, and applications of PMCs, MMCs, CMCs and Carbon-Carbon Composites. **Biomaterials:** Introduction, Materials used as biomaterials, advantages, disadvantages and applications.	

TEXT BOOKS:

1. Foundations of Materials Science and Engineering, Smith, 3rd Edition McGraw Hill, 2009
2. Materials Science, Shackleford and M. K. Muralidhara, Pearson Publication –2007.
3. Material Science, by Callister, Reprint 2008, Wiley India (P) LTD.
4. Material Science by V. Raghavan, Fifth Edition, PHI (P) LTD.
5. Introduction to physical metallurgy by Avner S H, 2nd Ed., MHP, 1985
6. Sujata V. Bhat, Biomaterials, Narosa Publishing House, 2002.

REFERENCE BOOKS:

1. Elements of Materials Science and Engineering, H. Van Vlack
2. Engineering Materials Science, W.C. Richards, PHI, 1965.
3. Physical Metallurgy; Lakhtin, Mir Publications.
4. Material Science and Engineering (SI Units), R.K. Rajput
5. Smart Materials and Structures, M V Gandhi and B S Thompson Chapmen &Hall
6. Material science and Metallurgy by K R Phaneesh, Sudha Publications-2005

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Differentiate crystal structures, imperfections, diffusion in solids, elastic and plastic properties of metal materials.

CO2: Analyze the various types of fracture, stages of creep and fatigue failure.

CO3: Describe mechanism of solidification, cast metal structure and rules for formation of solid solution.

CO4: Develop a capability to read a binary phase diagram and predict the properties that can be obtained by heat treatment and to know the characteristics and application of ferrous metals.

CO5: Know the different characteristics of nonferrous metals and their applicability for different applications and also know the physical and mechanical properties of composite materials also introduced to biomaterials.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1	1	2	1	0	1	2	0	1	0	3
CO2	2	1	1	2	1	0	1	2	0	1	0	3
CO3	2	1	1	2	1	0	1	2	0	1	0	3
CO4	2	2	1	2	1	0	1	2	0	1	0	3
CO5	2	1	1	2	1	0	1	2	0	1	0	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2019-20 ACADEMIC YEAR: 2020-21
SEMESTER : THIRD

COURSE TITLE : MECHANICS OF MATERIALS		
Sub Code: 18ME32	**No of Credits =4** **L-T-P-SS::3:2:0:0**	**No. of contact hours/week : 3L+2T** **Total Number of contact hours : 65**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Basic engineering mathematics**	

COURSE OBJECTIVES:

1. Understand mechanics of deformable bodies and apply them in analysis and design.
2. Analyze a body subjected to two dimensional and three dimensional stress systems.
3. Examine the stresses in thin and thick cylinders subjected to loads.
4. Evaluate the slope and deflection in beams subjected to different loading conditions.
5. Assess the stability of columns and struts.
6. Interpret the torsional behavior of structural members.

#	CONTENTS	Hrs.
UNIT-1	**SIMPLE STRESS AND STRAIN** (ONLINE TEACHING)	**9L+4T**
	Introduction, Stress, strain, mechanical properties of materials, Linear elasticity, Hooke's Law and Poisson's ratio, Stress-Strain relation – Ductile & Brittle, materials. Extension / Shortening of a bar, bars with cross sections varying in steps, bars with continuously varying cross sections (circular and rectangular), Elongation due to self-weight, Principle of super position. Stress in Composite Section**:** Volumetric strain, expression for volumetric strain, elastic constants, simple shear stress, shear strain, temperature stresses (including compound bars). Compound Stresses**:** Introduction, Plane stress, stresses on inclined sections, principal stresses and maximum shear stresses, Mohr's circle for plane stress.	
UNIT-2	**BENDING MOMENT AND SHEAR FORCE IN BEAMS** (BLENDED TEACHING)	**9L+4T**
	Introduction, Types of beams, loads and reactions, shear forces and bending moments, rate of loading, sign conventions, relationship between shear force and bending moments. Shear force and bending moment diagrams for different beams subjected to concentrated loads, uniformly distributed load, (UDL) uniformly varying load (UVL) and couple for different types of beams. Bending and Shear Stresses in Beams: Introduction, Theory of simple bending, assumptions in simple bending. Bending stress equation, relationship between bending stress, radius of curvature, relationship between bending moment and radius of curvature.	
UNIT-3	**DEFLECTION OF BEAMS** (CLASSROOM TEACHING)	**9L+4T**
	Moment carrying capacity of standard sections. Shearing stresses in beams, shear stress across rectangular, circular, symmetrical I and T sections. (Composite / notched beams not included). Introduction, differential equation for deflection. Equations for deflection, slope and bending moment. Double integration method for cantilever and simply supported beams for point load, UDL, UVL and Couple. Macaulay's method, Energy Methods: Work, strain energy, Strain energy in bar/beams due to various loads.	
UNIT-4	**TORSION OF CIRCULAR SHAFTS & ELASTIC STABILITY OF COLUMNS** (CLASSROOM TEACHING)	**9L+4T**
	Introduction. Pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts. Power transmitted by solid and hollow circular shafts columns**:** Euler's theory for axially loaded elastic long columns.	

	Derivation of Euler's load for various end conditions, limitations, Rankine's formula.	
UNIT-5	**CYLINDERS, PLATES AND SHELLS** (CLASSROOM TEACHING)	**9L+4T**
	Stresses in thin cylinders due to internal pressure, circumferential stresses & longitudinal stresses. Deformation in thin cylinders, stresses due to internal pressure of thick cylinders, Lame’s theory and numerical problem. Plates and Shells Classification, Bending of long rectangular plate to a cylindrical surface, Differential equation – Bending of plates with different boundary conditions – Long plates on elastic foundation, Pure Bending, Moment and curvature relations – problems of simply supported plates – strain energy in pure bending. General description of various types, Membrane Theory of Thin Shells (Stress Analysis), Cylindrical shells – spherical shells – shells of double curvature, viz., cooling tower, Hyperboloid, Paraboloid and elliptic paraboloid, Membrane deformation of shells: Symmetrically loaded cylindrical shell – symmetrically loaded spherical shell.	

TEXT BOOKS:

1.**"Strength of Materials",** S.S. Rattan, Tata McGraw Hill, 2009
2.**"Strength of Materials", S. Ramamrutham**

REFERENCE BOOKS:

1. **"Mechanics of materials",** James. M. Gere, Thomson, Fifth edition 2004.
2. **"Mechanics of materials",** in S.I. Units, Ferdinand Beer & Russell Johnstan, TMH.
3. **"Strength of Materials",** S.S.Bhavikatti, Vikas pub. House -1 Pvt. Ltd., 2nd Ed., 2006.
4. **"Engineering Mechanics of Solids**", Egor.P. Popov, Pearson Edu. India, 2nd, Edison, 1998.

COURSE OUTCOMES: On completion of the course, student should be able to:
CO1: Evaluate fundamental concepts of stresses, strains applied to members under loadings and material properties.
CO2: Understand the SFD and BMD for different types of loads and support conditions and relate bending stress, bending moment, radius of curvature.
CO3: Analyze Shear stresses in beams of different cross sections analyze the deflection in beams and Estimate the strain energy in mechanical elements.
CO4: Characterize torsional equation, power transmission in shafts and analyze buckling and bending phenomenon in columns, struts and beams
CO5: Analyze and design thin, thick cylinders and plates, shells.

MAPPING OF COs WITH POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	2	1	1	1	1	2	1	1
CO2	3	3	2	3	1	1	1	2	1	1	1	2
CO3	3	3	3	2	2	1	1	1	2	1	1	1
CO4	3	3	3	1	2	1	1	1	1	2	1	2
CO5	3	3	2	2	1	1	1	1	2	1	1	1

Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	

1. Two full questions (each of 20 Marks) are to be set from each unit.

2. Student shall answer five full questions selecting one full question from each unit.

ADMISSION YEAR : 2019-20 ACADEMIC YEAR: 2020-21
SEMESTER : THIRD

COURSE TITLE: MANUFACTURING PROCESSES - I		
Sub Code: 18ME33	**No of Credits =3** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Elements of Mechanical Engineering**	

COURSE OBJECTIVES:

1. This course will introduce the student to the various constituent of molding sand.
2. The course is to study various molding machines and casting process.
3. This course is to study various melting furnaces and welding process.

#	CONTENTS	Hrs
UNIT-1	**MOULDING MATERIALS, PROCESSES & MACHINES** (CLASS ROOM TEACHING)	**08**
	Introduction: Concept of manufacturing process, its importance. Classification of manufacturing processes and list different material handling methods. Introduction to casting process & steps involved. Components varieties, of produced by casting processes. Advantages & limitations of casting processes. **Patterns**: Definition, functions, materials used for pattern, various pattern allowances and their importance. Classification of patterns, BIS color coding of patterns. **Binder:** Definition, Types of binder used in molding sand. Additives: need, types of additives used and their properties. **Sand molding:** Sand, Types of base sand, requirement of base sand, molding sand mixture, ingredients for different sand mixtures. **Moulding machines:** Jolt type, Squeeze type, Jolt & Squeeze type and sand slinger. **Molding processes:** Method used for sand molding such as green sand, dry sand and skin dried moulds, sweep mold, CO2 mold, shell mold, flask less moulds, investment mould. **Cores:** Definition, need, types, method of making cores, binders used, core sand moulding, Concept of gating and risering.	
UNIT-2	**CASTING PROCESSES & MELTING FURNACES** (ONLINE TEACHING)	**08**
	Casting processes: Gravity die-casting, pressure die casting, centrifugal casting, and continuous casting processes. **Casting defects**: Causes, features and remedies. **Melting furnaces:** Classification of furnaces, Constructional features & working principle of coke fired, oil fired and gas fired pit furnace, resistance furnace, coreless induction furnace, electric arc furnace, Cupola furnace and process parameters.	
UNIT-3	**WELDING PROCESSES** (ONLINE TEACHING)	**07**
	Welding processes: Introduction, definition, principles, classification, application, advantages & limitations of welding. Arc welding: Principle, metal arc welding (MAW), flux shielded metal arc welding (FSMAW), inert gas welding (TIG & MIG). Briefing about latest welding processes. Resistance welding: Principles, seam welding, butt welding, spot welding and projection welding, friction welding, explosive welding, thermit welding.	
UNIT-4	**METALLURGICAL ASPECTS OF WELDING & INSPECTION METHODS** (BLENDED TEACHING)	**08**

	Metallurgical aspects: Structure of welds, formation of different zones during welding. Heat affected zone (HAZ), parameters affecting HAZ. Effect of carbon content on structure and properties of steel. **Inspection methods:** Methods used for inspection of casting and welding. Visual, magnetic particle, fluorescent particle, ultrasonic, radiography, eddy current, holography methods of inspection.	
UNIT-5	**MECHANICAL WORKING OF METALS** (ONLINE TEACHING)	**08**
	Introduction to metal forming processes & classification of metal forming processes. Hot working & cold working of metals. Forging: Smith forging, drop forging & press forging. Forging Equipment, Defects in forging. **Rolling:** Rolling process, Angle of bite, Types of rolling mills, Variables of rolling process, Rolling defects. **Drawing & Extrusion:** Drawing of wires, rods & pipes, Variables of drawing process. Difference between drawing & extrusion. Various types of extrusion processes. **Sheet Metal Operations:** Blanking, piercing, and punching.	

TEXT BOOKS:

1. **"Manufacturing Process-I & II",** Dr. K. Radhakrishna, Sapna Book House, 5th Revised Edition 2009.
2. **"Manufacturing & Technology**: Foundry Forming and Welding", P.N. Rao 2nd Ed, TMH, 2003.
3. **Manufacturing Science**, Amitabha Ghoshand Mallik, affiliated East West Press, 2003.
4. **Metal Casting: Principles and Practice**, T.V. Ramana Rao,Published by New Age International (P) Limited (2010)
5. **Principles of Metal Casting,** MahiSahoo **,** Sam Sahu **, McGraw Hill Education (India) Private Limited; Third edition (26 September 2014)**

REFERENCE BOOKS:

1. **"Manufacturing Technology**", Serope Kalpakjain, Steuen.R. Sechmid, Pearson Education Asia, 5th Ed. 2006.
2. **"Process and Materials of Manufacturing**", Roy A Lindberg, 4thEd. Pearson Edu. 2006.
3. **Principles of Metal Casting- Second Edition**, Heine, Richard W.; CarlR. Loper, Jr. & Philip C. Rosenthal, Published by McGraw-Hill, New York (1967)
4. **Mechanical Metallurgy Paperback,** George E. Dieter **TMH.**
5. **Metal Forming: Mechanics and Metallurgy**, Hosford,WF and Caddell,R.M, Published by Prentice Hall (1993)

COURSE OUTCOMES: On completion of the course, student should be able to;

CO1: Explain different manufacturing process, patterns, cores, moulding sand constituents, moulding process and machines.

CO2: Discuss different casting processes, defects and melting furnaces.

CO3: Understand the principle of metal arc, TIG, MIG, resistance, explosive and thermit welding processes.

CO4: Describe metallurgical aspect of welding, inspection of casting and welded components.

CO5: Understand the concepts of mechanical working of metals, forging, rolling, drawing, extrusion and sheet metal operations.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	0	1	2	0	1	3	1	1	0	1	3
CO2	1	0	1	2	0	1	3	1	1	0	1	3
CO3	1	0	1	2	0	1	3	1	1	0	1	3
CO4	1	0	1	2	0	1	3	1	1	0	1	3
CO5	1	0	1	2	0	1	3	1	1	0	1	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2019-20 ACADEMIC YEAR: 2020-21
SEMESTER : THIRD

COURSE TITLE : BASIC THERMODYNAMICS		
Sub Code: 18ME34	**No of Credits : L-T-P-SS 3:2:0:0= 4**	**No. of Contact hours/week : 3L+2T Total Number of contact hours : 65**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Engineering chemistry, physics, mathematics**	

COURSE OBJECTIVES:

1. To understand the fundamental concepts of thermodynamic system, process and cycle.
2. To explain work and heat transfer with illustrations and examples.
3. To interpret first and second law of thermodynamics in the context of closed and open system.
4. To understand the concept of entropy and the principle of increase of entropy.
5. To solve problems related to thermodynamic system applying the various thermodynamic relations to pure substances and gases.

#	**CONTENTS**	**Hrs.**
UNIT-1	**FUNDAMENTAL CONCEPTS** (BLENDED TEACHING)	**9L+4T**
	Macroscopic and microscopic viewpoint, thermodynamic system and control volume, thermodynamic property, process and cycle, homogeneous and heterogeneous system, thermodynamic equilibrium, quasi-static process, pure substance, concept of continuum, thermostatics, units and dimensions; zeroth law of thermodynamics, temperature scales, different types of thermometers. Work transfer, pdV work – path function and point function, pdV work in various quasi-static processes, indicator diagram, other types of work transfer, free expansion with zero work transfer, net work done by a system, heat transfer, heat transfer as a path function, specific heat and latent heat, comparison of heat and work transfer; Numerical problems.	
UNIT-2	**FIRST LAW OF THERMODYNAMICS** (CLASSROOM TEACHING)	**9L+4T**
	First law of a closed system undergoing a cycle (Joule's experiment) and undergoing a change of state, energy as a property of a system, forms of stored energy, specific heat at constatn volume and constant pressure, enthalpy, energy of an isolated system, PMM 1, limitations of the first law; application of first law to flow processes – control volume, steady flow process, mass and energy balance in a simple steady flow process, examples of steady flow processes -turbines, pumps, nozzles and diffusers; Numerical problems.	
UNIT-3	**SECOND LAW OF THERMODYNAMICS AND ENTROPY** (CLASSROOM TEACHING)	**9L+4T**
	Qualitative difference between heat and work, cyclic heat engine, energy reservoirs, kelvin-planck and clausius statement of second law of thermodynamics, PMM 2, refrigerator and heat pump, equivalence of kelvin-planck and clausius statements, reversibility and irreversibility, causes and conditions of irreversibility, carnot cycle, reversed heat engine, carnot's theorem and its corollary, absolute thermodynamic temperature scale, efficiency of the reversible heat engine, equality of ideal gas and Kelvin temperatures, types of irreversibility, numericals. Entropy - Introduction, clausius theorem, The property of entropy, T-S plot, clausius inequality, entropy change in an irreversible process, entropy principle and its applications. Numerical problems.	

UNIT-4	**AVAILABILITY AND PROPERTIES OF PURE SUBSTANCE** (CLASSROOM TEACHING)	**9L+4T**
	Availability, Irreversibility and General Thermodynamic relations. Introduction, Availability (Exergy), Unavailable energy, Relation between increase in unavailable energy and increase in entropy. Maximum work, maximum useful work for a system and control volume, irreversibility; Pure substances: p-V diagram and p-T diagram, p-v-T surface, T-s and h-s diagram for a pure substance, quality of pure substance, steam tables – saturation state, liquid-vapour mixture, compressed liquid, charts of thermodynamic properties, measurement of steam quality – throttling calorimeter, separating and throttling carlorimeter; Numerical problems.	
UNIT-5	**IDEAL AND REAL GASES** (ONLINE TEACHING)	**9L+4T**
	Ideal gases: Ideal gas mixtures, Daltons law of partial pressures, Amagat's law of additive volumes, evaluation of properties of perfect and ideal gases, Air- Water mixtures and related properties. Real gases – Introduction, Van-der Waal's Equation of state, Van-der Waal's constants in terms of critical properties, Beattie-Bridgeman equation, Law of corresponding states, compressibility factor; compressibility chart. Difference between Ideal and real gases; Numerical problems.	

TEXT BOOKS

1.**Engineering Thermodynamics**, P.K. Nag, Tata McGraw Hill Education (India) Publications, 5th Edition, 2013.

2.**Thermodynamics:An Engineering Approach**, Yunus A. Cenegal and Michael A. Boles, McGraw-Hill Publications (SIE), 8th Edition, 2015.

3. **A Text Book of Engineering Thermodynamics**, R.K. Rajput, Laxmi Publishers, 3rd Edition, 2010.

REFERENCE BOOKS

1. Applications of Thermodynamics, V. Kadambi, T R Seetharam and K B Subramanya Kumar, Wiley India Private Limited, 1st Edition, 2019

2. Fundamentals of Thermodynamics, Claus Borgnakke and Richard E. Sonntag, Wiley Student Edition, 7th Edition, 2009.

3. Fundamentals of Engineering thermodynamics by H . N. Shapiro & M J Moran.

e-LEARNING RESOURCES

Videos and Lecture Notes: http:// www.nptel.ac.in

DATA HAND BOOK

Thermodynamics Data Book, B T Nijaguna and B S Samaga, Sudha Publishers, 2016.

COURSE OUTCOME (CO)

After the completion of the course, the students will be able to:

CO1: *Explain* the concept of thermodynamic system and its interaction with surroundings; *differentiate* work and heat transfer in various quasistatic thermodynamics processes; and *solve* related numerical problems (RBTL 1, 2, 3)

CO2: *Interpret* the first law of thermodynamics applied to a thermodynamic system and a flow process; and *solve* related numerical problems (RBTL 1, 2, 3).

CO3: *Understand* the Kelvin-Planck and Clausius statements of second law of thermodynamics; *understand* the concept of entropy principle and its applications to thermodynamic processes; *summarize* thermodynamic relations; and *solve* related numerical problems (RBTL 1, 2, 3).

CO4: *Understand* the concept of availability and irreversibility; *understand* various thermodynamic property diagrams for a pure substance; *use* the steam tables; (RBTL 1, 2, 3)
CO5: D*iscuss* ideal and real gases; and *solve* related numerical problems (RBTL 1, 2, 3)
(RBTL: Revised Bloom's Taxonomy Levels; 1 – Remembering, 2 – Understanding, 3 – Applying, 4 - Analyzing, 5 - Evaluating, 6 - Creating)

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	0	0	0	2	1	1	1	0	1
CO2	3	3	2	0	0	0	2	1	1	1	0	1
CO3	3	3	3	0	0	0	2	1	1	1	0	1
CO4	3	3	3	0	0	0	2	1	1	1	0	1
CO5	3	3	3	0	0	0	2	1	1	1	0	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2019-20 ACADEMIC YEAR: 2020-21
SEMESTER : THIRD

COURSE TITLE : COMPUTER AIDED MACHINE DRAWING		
Sub Code: 18MEL35	**No of Credits =3** **L-T-P-SS::2:0:2:0**	**No. of lecture hours/week : 04**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 50**
Pre-requisites	**Computer Aided Engineering Drawing, Solid edge software**	

COURSE OBJECTIVES:
1. To understand the sectional views and developments of various solid shapes.
2. Simple machine parts orthographic views with and without sections to be under-stood.
3. Different types of thread forms to be studied.
4. Permanent and temporary fasteners study
5. Assembly drawings in 2D of several joints.

#	CONTENTS	Hrs.
UNIT-1	**SECTIONS OF SOLIDS AND ORTHOGRAPHIC PROJECTIONS** (ONLINE TEACHING)	**12**
	Introduction to geometrical dimensions & tolerances **Sections of solids:** Prisms, pyramids, cones, cylinders cut by a single section plane perpendicular to vertical plane and inclined to horizontal plane **Orthographic projections:** Orthographic views of simple machine parts with and without sections	
UNIT-2	**THREAD FORMS, FASTENERS, KEYS AND RIVETED JOINTS** (BLENDED TEACHING)	**12**
	Thread Forms: Thread forms: thread terminology, sectional views of threads. ISO Metric (internal & external) BSW (internal & external) square and Acme. Sellers thread, American Standard thread. **Fasteners:** Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut, flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw. **Keys & Joints**: Parallel key, taper key, feather key, gib head key and woodruff key. Cotter joint (socket and spigot), knuckle joint (pin joint) for two rods. **Riveted joints:** Single and double riveted lap joints, butt joints with single/double cover straps (chain and zigzag, using snap head rivets).	
UNIT-3	**ASSEMBLY DRAWINGS** (ONLINE TEACHING)	**28**
	Connecting Rod, Plummer block (Pedestal bearing), Tail Stock, Screw jack (Bottle type), Machine vice	

TEXT BOOKS:
1. Computer Aided Machine Drawing 2007, Published by VTU, Belgaum

REFERENCE BOOKS:
1. Machine Drawing', K.R. Gopala Krishna, Subhash Publication.
2. Machine Drawing', N. D. Bhat& V. M. Panchal
3. Computer Aided Machine Drawing' Trymbaka Murthy, CBS Publishers, New Delhi 2007
COURSE OUTCOMES:
On completion of the course, student should be able to;

CO1: Understand Section of solid and orthographic projections of machine elements.
CO2: Identifying several thread forms and pinpointing their usage.
CO3: Realize fasteners and their importance with specific decision to select the right type of fastener for the right job.
CO4: Understand the part or assembly drawings as per the conventions.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	2	1	1	1	1	1	1	1
CO2	3	3	3	1	2	1	1	1	1	1	1	1
CO3	3	3	3	1	2	1	1	1	1	1	1	1
CO4	3	3	3	1	2	1	1	1	1	1	1	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

CONTINUOUS INTERNAL EVALUATION (CIE)

1. CIE has a maximum of 50 marks
2. All the drawings should be drawn in the class using Solid edge software. Sheet sizes should be A4. All sheets must be submitted at the end of the class by taking printouts.
3. CIE Marks is finalized by conducting a test at the end of 10^{th} week of the semester
4. CIE Marks (50) = Evaluation of Record (Sketch-15 and Printout-15) + Test (20)

QUESTION PAPER PATTERN (SEE)							TOTAL MARKS
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	
UNIT	1		2		3		
MARKS	10		10		30		**50**
1. Two full questions (each of 20 Marks) are to be set from each unit.							
2. Student shall answer totally three full questions selecting one full question from each unit.							

ADMISSION YEAR : 2019-20 ACADEMIC YEAR: 2020-21
SEMESTER : THIRD

COURSE TITLE : MANUFACTURING PROCESSES LABORATORY - I		
Sub Code: 18MEL36	**No of Credits: L-T-P-SS :: 00:00:02:00 = 01**	**No. of practical hours/week: 02**
Exam Duration : 03 hours	**CIE Marks: 50**	**Exam Marks : 50**
Pre-requisites	**Elements of Mechanical Engineering, Manufacturing Processes I**	

COURSE OBJECTIVES:

1) This course will give the student knowledge of testing sand used in foundries.
2) It also focuses on preparation of sand molds with and without patterns and also to cast a component

#	CONTENTS	Hrs
PART - A	**SAND TESTING**	**10**
	Preparation of sand specimen and its testing using **(a) Universal Sand Testing Machine** – Compression, Shear & Tensile test **(b) Permeability Meter -** Permeability test **(c) Sieve Shaker -** Sieve analysis to find Grain Fineness number of base sand **(d) Clay Stirrer -C**lay content determination in base sand **(e) Hot Air Oven -** Core & Mold hardness tests	
PART - B	**FOUNDRY**	**16**
	Use of foundry tools: Preparation of molds with and without patterns. Preparation of a casting (Aluminum or cast iron-Demonstration only)	

REFERENCE BOOKS:

1. "Manufacturing & Technology Foundry Forming and Welding", P.N. Rao 2 Ed.Tata Mc Graw Hill, 2003.
2. Manufacturing Science, Amitabh Ghosh and Mallik, affiliated East West Press,2003.
3. Metal Casting: Principles and Practice, T.V. Ramana Rao, Published by New Age
4. Principles of Metal Casting, Mahi Sahoo, Sam Sahu McGraw Hill Education (India) Private Limited; Third edition (26 September 2014).

COURSE OUTCOMES: On completion of the course, student should be able to:
CO1: Preparation of standard sand specimens and conduct of various tests on it.
CO2: To read working drawings, understand operational symbols and prepare moulds as per dimensions.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	0	2	2	2	0	0	0	0	1	1	0	0
CO2	0	0	2	1	0	0	0	0	1	1	1	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

CONTINUOUS INTERNAL EVALUATION (CIE)

1.CIE has a maximum of 50 marks.

2.CIE Marks is finalized by conducting a test at the end of 12^{th} week of the semester.

3.CIE Marks (50) = Evaluation of Record (30) + Test (20)

SCHEME OF CONTINUOUS INTERNAL EVALUATION (CIE)

RECORD WRITING	
PART-A	
Sand Testing tools, instruments and AFS standards	05 MARKS
Experiments in sand testing	10 MARKS
PART-B	
Foundry tools and operations	05 MARKS
Foundry models	10 MARKS
TOTAL – 1	**30 MARKS**
CIE at the end of 12^{th} week of the semester	
One sand testing experiment from PART A	15 MARKS
One foundry Model from PART B	25 MARKS
Viva – Voce	10 MARKS
	50 MARKS
TOTAL – 2 = 50/2.5	**20 MARKS**
GRAND TOTAL (TOTAL-1+TOTAL-2)	**50 MARKS**

SCHEME OF SEMESTER END EXAMINATION (SEE)	
One sand testing experiment from PART A	15 MARKS
One foundry Model from PART B	25 MARKS
Viva – Voce	10 MARKS
TOTAL	**50 MARKS**

ADMISSION YEAR : 2019-20 ACADEMIC YEAR: 2020-21
SEMESTER : THIRD

COURSE TITLE : MATERIAL TESTING LABORATORY		
Sub Code: 18MEL37	**No of Credits =1** **L-T-P-SS::0:0:2:0**	**No. of practical hours/week : 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 50**
Pre-requisites	**Material science and metallurgy**	

COURSE OBJECTIVES:

1) To focus on the standards to be followed for mechanical properties estimation
2) To understand the need for the methods of mechanical properties testing
3) To know the salient steps in preparing test specimens for microstructure study
4) To introduce concept of non-destructive testing.

#	CONTENTS	Hrs
PART A	**TESTING OF MATERIALS AS PER ASTM STANDARDS**	**16**
	Explain ASTM and BIS standards. Tensile, shear and compression tests of metallic and non-metallic specimens using Universal Testing Machine, Torsion Test, Bending Test on metallic and nonmetallic specimens, Fatigue Test	
PART B	**FRACTURE, HARDNESS TESTING AND NDT**	**10**
	Izod and Charpy Tests, Brinell, Rockwell and Vickers's Hardness test. Demonstration on Identification of microstructures. To study the defects of Cast and Welded specimens using Non-destructive test experiments like, (a) Magnetic crack detection (b) Dye penetration testing equipment.	

REFERENCE BOOKS:

1."Mechanical Metallurgy"**, George E Dieter, Mc Graw Hill Publications, 1986.**
2."Strength of Materials", **S.S. Rathan, Tata McGraw Hill Publications, Second Edition**
3. ASTM Standard Hand Books.

COURSE OUTCOMES: On completion of the course, student should be able to:
CO1: Acquire experimentation skills in the field of material testing.
CO2: Develop theoretical understanding of the mechanical properties of materials by performing experiments.
CO3: Apply the knowledge to analyze a material failure and determine the failure inducing agent/s.
CO4: Apply the knowledge of testing methods in related areas.

MAPPING OF COs WITH POs												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	0	0	0	0	0	0	0	0	0	2	0	0
CO2	1	3	2	3	0	0	0	0	2	1	1	1
CO3	0	2	1	3	0	0	0	0	2	2	1	0
CO4	0	1	2	3	2	1	0	0	1	2	1	0
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

CONTINUOUS INTERNAL EVALUATION (CIE)

1. CIE has a maximum of 50 marks i.e., Evaluation of Record (30) + Test (20)
2. CIE Marks is finalized by conducting ONE test at the end of 10^{th} week of the semester.

SCHEME OF EXAMINATION (SEE)	
ONE question from Part A	25 MARKS
ONE question from Part B	15 MARKS
Viva – Voce	10 MARKS
TOTAL	50 MARKS

ADMISSION YEAR : 2019-20 ACADEMIC YEAR: 2020-21
SEMESTER : THIRD

COURSE TITLE : FITTING & FORGING WORKSHOP		
Sub Code: 18MEL38	**No of Credits L-T-P-SS :: 0:0:2:0 = 01**	**No. of practical hours/week: 02**
Exam Duration :03 hours	**CIE Marks: 50**	**Examination Marks : 50**
Pre-requisites	**Elements of Mechanical Engineering, Manufacturing Processes**	

COURSE OBJECTIVES:

1. To give an introduction to fitting tools and their operations to make models
2. To forge a model involving various forging operations

#	CONTENTS	Hours
PART A	**FITTING**	**10**
	Demonstration of fitting tools, operations and model making	
PART B	**FORGING**	**16**
	Forging Models preparation • Calculation of length of the raw material required to do the model. • Preparing minimum three forged models involving Upsetting, Drawing and Bending operations	

REFERENCE BOOKS:

1. Workshop Technology Vol.1 & Vol.2, Hajra Chowdhary

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Fitting tools, operations and model making

CO2: Analyze and utilize tools in forging operation to make a model with care as per the set dimensions.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	1	1	2	2	2	3	3	3	2	2
CO2	3	3	1	1	2	2	2	3	3	3	2	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

CONTINUOUS INTERNAL EVALUATION (CIE)

1. CIE has a maximum of 50 marks.
2. CIE Marks is finalized by conducting a test at the end of 12^{th} week of the semester.
3. CIE Marks (50) = Evaluation of Record (30) + Test (20)

SCHEME OF CONTINUOUS INTERNAL EVALUATION (CIE)	
RECORD WRITING	
PART-A	
Fitting tools, operations and model making	15 MARKS
PART-B	
Forging tools, operations and model making	15 MARKS
TOTAL – 1	**30 MARKS**
CIE at the end of 12^{th} week of the semester	
One fitting model	20 MARKS
One forging model	20 MARKS
Viva – Voce	10 MARKS
	50 MARKS
TOTAL – 2 = 50/2.5	**20 MARKS**
GRAND TOTAL (TOTAL-1+TOTAL-2)	**50 MARKS**

SCHEME OF SEMESTER END EXAMINATION (SEE)	
FITTING	20 MARKS
FORGING	20 MARKS
Viva – Voce	10 MARKS
TOTAL	**50 MARKS**

ADMISSION YEAR : 2019-20 ACADEMIC YEAR: 2020-21
SEMESTER : FOURTH

COURSE TITLE : MECHANICAL MEASUREMENTS		
Sub Code: 18ME41	**No of Credits =3** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Engineering physics, Basic electrical engineering**	

COURSE OBJECTIVES:

1. Explain the concepts of measurement and gauging instruments.
2. To provide knowledge on various metrological equipment's available to measure the dimension of the components.
3. To provide knowledge on the correct procedure to be adopted to measure the dimension of the components.
4. Explain and apply the principles in manufacturing industries.

#	**CONTENTS**	**Hrs.**
UNIT-1	**STANDARDS OF MEASUREMENT, LIMITS, FITS AND TOLERANCE** (CLASSROOM TEACHING)	**08**
	Standards of measurement: Definition and Objectives of metrology, standards of length- international prototype meter, imperial standard yard, wave length standard, subdivision of standards, line and end standard, calibration of end bars (Numerical), slip gauges, wringing phenomena, Indian standards (M-81, M-12), numerical problems on building of slip gauges. **Limits, fits and tolerance:** definition, need for limit systems, definition of fits, types of fits and their designation (IS919-1963), hole basis system, shaft basis system. definition of tolerance, principle of interchangeability and selective assembly ,concept of limits of size and tolerance specification in assembly, and tolerances, compound tolerances, accumulation of tolerances, geometrical tolerance, positional-tolerances.	
UNIT-2	**GAUGES AND LINEAR MEASUREMENTS** (ONLINE TEACHING)	**07**
	Gauges: Design of limit gauges by Taylor's principle, types of gauges-plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials wear allowance on gauges. **Linear Measurements:** introduction to comparators, characteristics, classification of comparators, mechanical comparators-Johnson Mikrokator, sigma comparators, dial indicator, optical comparators- Mechanical-optical comparators, Zeiss ultra-optimeter, electric and electronic comparators- LVDT, pneumatic comparators, Velocity and back pressure type, solex comparator.	
UNIT-3	**ANGULAR MEASUREMENTS AND INTERFEROMETRY** (CLASSROOM TEACHING)	**07**
	Angular measurements: Bevel protractor, sine principle and use of sine bars, sine center, use of angle gauges (numerical on building of angles), and clinometers. Surface roughness-Straightness, flatness, perpendicularity, parallelism, roundness and cylindrical. **Interferometry**: Interferometer, autocollimator. Optical flats. Terminology of screw threads, profile projector- measurement of major diameter, minor diameter, pitch, angle and effective diameter of screw threads by 2-wire and 3-wire methods, tool maker's microscope, gear tooth, terminology, use of gear tooth	

	vernier caliper and micrometer.	
UNIT-4	**MEASUREMENT AND MEASUREMENT SYSTEMS** (CLASSROOM TEACHING)	**09**
	Measurement: Definition, significance, accuracy, Resolution precision, calibration, threshold, sensitivity, hysterisis, repeatability, linearity, Errors, classification of errors. **Generalized measurement systems:** Transducers - transfer efficiency, primary and secondary transducers, electrical, mechanical, electronic transducers, advantages. Intermediate modifying devices - Mechanical systems, electronic amplifiers and telemetry. Terminating devices- cathode ray oscilloscope, oscillographs, X-Y plotters.	
UNIT-5	**FORCE, TORQUE, PRESSURE, TEMPERATURE AND STRAIN MEASUREMENT** (ONLINE TEACHING)	**08**
	Force measurement – Introduction, direct methods, indirect methods and Proving ring **Torque measurements-** Introduction, mechanical dynamometers, hydraulic dynamometers and electrical dynamometers. **Pressure measurements:** introduction**,** definition of pressure terms, methods of measuring pressure- pressure measurement with elastic transducers, Bridgeman gauge, McLeod gauge. **Temperature measurements:** Resistance thermometers, thermocouple, law of thermocouple, materials used for construction, pyrometer, optical pyrometer. **Strain measurements**, Wheatstone resistance bridge arrangement for strain measurement, gauge factor, mechanical strain gauge, Resistance strain gauge, Electrical strain gauge	

TEXT BOOKS:

1. **Mechanical Measurements,** Beckwith Marangoni and Lienhard, Pearson Education, 6th Edition, 2006. (For Measurements Only)
2. **Engineering Metrology,** R.K. Jain, Khanna Publishers, 1994. (For Metrology Only)

REFERENCE BOOKS:

1. **Engineering Metrology,** I.C. Gupta, Dhanpat Rai Publications, Delhi.
2. **Mechanical Measurements,** R.K. Jain
3. **Industrial Instrumentation,** Alsutko, Jerry. D. Faulk, Thompson Asia Pvt. Ltd.2002.
4. **Measurement Systems Applications and Design,** Ernest O. Doblin, McGraw Hill

COURSE OUTCOMES: On completion of the course, student should be able to:
CO1: Describe different standards and the importance of standardization.
CO2: Recognize measurements necessity, various dimensional measurements.
CO3: Design measurement system for a given parameter
CO4: List the different kinds of sensors, transducers, and recorders.
CO5: Assess measurement system with its limitations.

MAPPING OF COs WITH Pos												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	0	0	1	1	1	1	2	0	2
CO2	3	3	2	0	0	1	1	1	1	1	0	2
CO3	3	3	2	0	0	1	1	1	1	2	0	2
CO4	3	3	2	0	0	1	1	1	1	2	0	2
CO5	3	3	3	0	0	1	1	1	1	1	0	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR :	2019-20	ACADEMIC YEAR: 2020-21
SEMESTER :	FOURTH	

COURSE TITLE : FLUID MECHANICS		
Sub Code: 18ME42	**No of Credits : L-T-P-SS 3:2:0:0 =4**	**No. of contact hours/week : 3L+2T Total Number of contact hours : 65**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Physics, Mathematics**	

COURSE OBJECTIVES:

1. Explain various properties related to fluid mechanics.
2. Determine hydrostatic force and centre of pressure on plane and curved surfaces, locate met centre and Meta centric height of floating bodies.
3. Summarize different types of pressure measurement devices.
4. Apply laws of conservation of momentum, mass and energy to fluid flow systems and explain the measurement of fluid flow parameters.
5. Interpret compressibility of gases in terms of Mach number.

#	CONTENTS	Hrs.
UNIT-1	**PROPERTIES OF FLUID** (BLENDED TEACHING)	**9L+4T**
	Introduction, classification of fluids, properties of fluids, viscosity, thermodynamic properties, surface tension, capillarity, vapour pressure, cavitation phenomenon. Numerical problems. **Fluid statics:** Fluid pressure at a point, Pascal's law, pressure variation in a static fluid, absolute, gauge, atmospheric and vacuum pressures, simple manometers and differential manometers. Numerical problems.	
UNIT-2	**SUBMERGED BODIES AND BUOYANCY** (CLASSROOM TEACHING)	**9L+4T**
	Submerged bodies: Total pressure and center of pressure on submerged plane surfaces; horizontal, vertical and inclined plane surfaces, curved surface submerged in liquid. Related numerical problems. **Buoyancy:** Buoyancy, center of buoyancy, metacentre and metacentric height, conditions of equilibrium of floating and submerged bodies, determination of metacentric height experimentally and theoretically. Numerical problems.	
UNIT-3	**FLUID KINEMATICS AND DYNAMICS** (CLASSROOM TEACHING)	**9L+4T**
	Fluidkinematics: Types of fluid flow, continuity equation in 2Dand 3D (Cartesian Co-ordinates only), velocity and acceleration, Numerical problems. **Fluid dynamics:** Introduction, Equation of motion, Euler's equation of motion, Bernoulli's equation from first principles and also from Euler's equation, limitations of Bernoulli's equation. Numerical problems.	
UNIT-4	**FLUID FLOW MEASUREMENTS AND FLOW THROUGH PIPES** (CLASSROOM TEACHING)	**9L+4T**
	Fluid flow measurements: Applications of Bernoulli's equation, venturimeter, orifice meter, pitot-tube, vertical orifice, V-notch and rectangular notches, Numerical problems. Navier-stoke’s Equation. **Flow through pipes:** Introduction, major and minor losses through pipes. Darcy's and Chezy's equation for loss of head due to friction in pipes. HGL and TEL. Numerical problems. **Laminar flow and viscous effects:** Reynold's number, critical Reynold's number, laminar flow through circular pipe-Hagen Poiseille's equation, laminar flow between parallel and stationary plates. Numerical problems.	
UNIT-5	**FLOW PAST IMMERSED BODIES AND COMPRESSIBLE FLOW**	**9L+4T**

	(ONLINE TEACHING)	
	Flow past immersed bodies: Introduction, drag, lift, expression for lift and drag, boundary layer concept, displacement, momentum and energy thickness. Numerical problems. **Compressible flow:** introduction – stagnation properties relationship, velocity of sound in a fluid, mach number, mach cone, propagation of pressure waves in a compressible fluid. Numerical problems. **Introduction to Computational Fluid Dynamics (CFD):** Necessity, limitations, philosophy behind CFD, applications; Commercial softwares available for CFD analysis.	

TEXT BOOKS

1. **A Textbook of Fluid Mechanics and Hydraulic Machines (SI Units)**, Dr. R.K. Bansal, Laxmi Publications (P) Limited, Revised 9th Edition,, 2010.

2. **Fluid Mechanics: Fundamentals and Applications (SI Units),**Yunus A. Cengel, JohnM.Cimbala. McGraw-Hill Publications (SIE), 3rd Edition, 2014.

REFERENCE BOOKS

1. **Hydraulics and Fluid Mechanics including Hydraulic Machines**, Dr. P.N. Modi and S.M. Seth, Rajsons Publications Private Limited, Standard Book House, 2009.
2. **Fluid Mechanics**, Frank M. White, McGraw-Hill Publications (SIE), 7th Edition, 2011.
3. **A Text Book of Fluid Mechanics,** R K Rajput, S Chand Publishers , 1998.

e-LEARNING RESOURCES

1. **Fluid Mechanics: Mechanical Engineering Handbook,** Kreith,F, Berger, S.A, et. al., Ed. Frank Kreith, Boca Raton: CRC Press LLC, 1999.
2. **Videos and Lecture Notes:** http://www.nptel.ac.in

MASSIVE OPEN ONLINE COURSES (MOOCs):

Students are encouraged to visit http:// www.nptel.ac.in (http:// www.swayam.gov.in) and register for the following MOOCs:
Fluid Mechanics (8 Week Course; July-Oct)

COURSE OUTCOME (CO): After completion of the course, students will be able to:

CO1: *Understand* how a fluid is classified and *define* various properties of a fluid; *understand* Pascal's law and *explain* various types of manometers; and *solve* related numerical problems (RBTL 1, 2, 3)

CO2: *Explain* the total pressure and centre of pressure acting on submerged surfaces; *understand* the concept of buoyancy, metacentre and metacentric height of floating and submerged bodies; and *solve* related numerical problems (RBTL 1, 2, 3)

CO3: *Describe* the types of fluid flow and *understand* the continuity, Euler and Bernoulli's equation; *solve* numerical problems related to fluid kinematics and dynamics (RBTL 1, 2, 3)

CO4: *Explain* different types of flow measuring devices; *understand* the minor and major losses; *discuss* Darcy and Chezy equations; *describe* Reynolds number and *understand* the derivation of flow through circular pipe, laminar flow between parallel and stationary plates; and *solve* related numerical problems (RBTL 1, 2, 3)

CO5: *Understand* the terms related to fluid flow past an immersed body; *explain* boundary layer, displacement, momentum and energy thickness; *understand* the relationship of stagnation properties applicable to compressible flow; *explain* Mach number and Mach cone;

and *solve* related numerical problems (RBTL 1, 2, 3).
(RBTL: Revised Bloom's Taxonomy Level 1 – Remembering, 2 – Understanding, 3 – Applying, 4 - Analyzing, 5 - Evaluating, 6 - Creating)

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	0	0	0	2	1	1	1	0	1
CO2	3	3	2	0	0	0	2	1	1	1	0	1
CO3	3	3	3	0	0	0	2	1	1	1	0	1
CO4	3	3	3	0	0	0	2	1	1	1	0	1
CO5	3	3	3	0	0	0	2	1	1	1	0	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										
3. Each full question shall have maximum of 3 sub-divisions.										

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ADMISSION YEAR : 2019-20 ACADEMIC YEAR: 2020-21
SEMESTER : FOURTH

COURSE TITLE : MANUFACTURING PROCESSES - II		
Sub Code: 18ME43	**No of Credits =3** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours		**Exam Marks : 100**

COURSE OBJECTIVES:

1. To expose the students to production techniques including their typical use and capabilities.
2. To teach the students mechanical aspects of manufacturing processes, such as cutting force, tool life.
3. To provide students a technical understanding of common traditional processes and non-traditional processes to aid in appropriate process selection for the material and required tolerances.

#	CONTENTS	Hrs
UNIT-1	**THEORY OF METAL CUTTING** (CLASSROOM TEACHING)	**08**
	Single point cutting tool nomenclature, geometry. Mechanics of Chip Formation, Types of Chips. Merchants circle diagram and analysis, Ernst Merchant’s solution, shear angle relationship, problems on Merchant’s analysis. Tool Wear and Tool failure, tool life. Effects of cutting parameters on tool life. Tool Failure Criteria, Taylor’s Tool Life equation. Problems on tool life evaluation.	
UNIT-2	**CUTTING TOOL MATERIALS** (ONLINE TEACHING)	**08**
	Desired properties and types of cutting tool materials – HSS, carbides, coated carbides, ceramics. Cutting fluids. Desired properties, types and selection. Heat generation in metal cutting, factors affecting heat generation. Heat distribution in tool and work piece and chip. Measurement of tool tip temperature.	
UNIT-3	**LATHES, SHAPING, PLANING AND SLOTTING MACHINES** (CLASSROOM TEACHING)	**07**
	LATHES, SHAPING, PLANING AND SLOTTING MACHINES Classification, constructional features, Different operations, work holding and tool holding devices on lathes, turret and capstan lathe, shaping machine, planing machine and slotting machines. Simple problems on machining time calculations.	
UNIT-4	**DRILLING, MILLING, HOBBING, GRINDING AND BROACHING MACHINES** (BLENDED TEACHING)	**09**
	DRILLING AND MILLING MACHINES: Classification, constructional features, drilling & related operations. Types of drill & drill bit nomenclature, drill materials, milling cutters nomenclature, milling operations, up milling and down milling concepts. Various milling operations. Indexing: Simple, compound, differential and angular indexing calculations. Hobbing - Principle of working, related operations and its applications, Simple problems on simple and compound indexing. **GRINDING MACHINE -** Types of abrasives, Grain size, bonding process, grade and structure of grinding wheels, grinding wheel types. Classification, constructional features of grinding machines (Centerless, cylindrical and surface grinding). Selection of grinding wheel, Grinding process parameters. Dressing and truing of grinding wheels. **BROACHING MACHINE -** Principle of broaching. Details of a broach. Types of broaching machines-constructional details, applications, advantages and limitations. (CLASSROOM TEACHING)	

UNIT-5	**FINISHING PROCESSES** (BLENDED TEACHING)	**07**
	LAPPING AND HONING OPERATIONS – Principles, arrangement of set up and application. **SUPER FINISHING PROCESS**: Polishing, buffing operation and application. **NON-TRADITIONAL MACHINING PROCESSES** Classification, Mechanism of material removal, Principle of working, process parameters, process capabilities, application, advantages and limitations of ECM, EDM, WEDM and USM.	

TEXT BOOKS:

1. **Workshop Technology,** Hajra Choudhry, Vol-II, Media Promoters & Pub. Pvt. Ltd. 2004
2. **Production Technology,** R.K.Jain, Khanna Publications, 2003.
3. **Production Technology,** HMT, Tata McGraw Hill, 2001.
4. Manufacturing Technology - Vol. 2, P N Rao, TMH Education; 3rd edition (1 May 2013)
5. Production Technology, P.C. Sharma, S Chand (1 December 2006)

REFERENCE BOOKS:

1. **Manufacturing Science**, Amitabha Ghosh and Mallik, affiliated East West Press, 2003.
2. **Fundamentals of Metal Machining and Machine Tools,** G.Boothroyd, McGraw Hill, 2000.

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Understand different types of tools, chips, tool wear, tool failure criteria, forces acting during metal cutting and metal cutting theories.

CO2: Classify different cutting tools, their properties and applications.
Understand and analyze the effect of temperature, strain rate in metal working, heat affected zones and learn different tool materials.

CO3: have in depth knowledge on working of lathe, shaping, planning and slotting machines, different machining operations performed, tool and work holding devices and heat generated during metal cutting.

CO4: have in depth knowledge on working of drilling, milling, hobbling grinding and broaching machines, different machining operations performed on them and their applications.

CO5: Differentiate and understand different finishing operations, non-traditional machining processes based on the mechanism of material removal, working principle and analyze the process parameters.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	1	0	0	0	1	1	0	1	2	1	2
CO2	3	1	0	0	0	1	1	0	1	2	1	2
CO3	3	1	0	0	0	1	1	0	1	2	1	2
CO4	3	1	0	0	0	1	1	0	1	2	1	2
CO5	3	1	0	2	0	1	1	0	1	2	1	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2019-20 ACADEMIC YEAR: 2020-21
SEMESTER : FOURTH

COURSE TITLE : APPLIED THERMODYNAMICS		
Sub Code: 18ME44	**No of Credits : L-T-P-SS 3:2:0:0 =4**	**No. of contact hours/week : 3L+2T Total Number of contact hours : 65**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Fluid mechanics, Engineering thermodynamics**	

COURSE OBJECTIVES

1. To relate the fundamentals of thermodynamics to the real time applications.
2. To describe the various thermodynamic power cycles which use air and vapour as the working fluid
3. To apply the fundamental concepts to derive various thermodynamic variables for solving numerical problems
4. To understand and determine the performance parameters of various thermodynamic systems.

#	CONTENTS	Hrs.
UNIT-1	**AIR STANDARD POWER CYCLES** (BLENDED TEACHING)	**9L+4T**
	Introduction; Description, work and heat transfers of various thermodynamic processes, p-v and T-s diagrams, Air standard cycles - derivation of efficiency and mean effective pressure of Carnot, Otto, Diesel, dual combustion and Stirling cycles; IC Engines – Combustion of SI and CI engines, Detonation and factors affecting detonation; Testing and performance of IC engines: basic measurements – engine speed, fuel consumption, air consumption, exhaust Smoke, IP, BP, FP measurements, heat balance sheet, Alternate Fuels, Numerical problems.	
UNIT-2	**GAS TURBINE CYCLES AND JET PROPULSION** (CLASSROOM TEACHING)	**9L+4T**
	Introduction; Analysis of simple gas turbine cycle (Brayton cycle); Methods to improve the performance of gas turbine plant – efficiency of regenerative gas turbine cycle; Reheat gas turbine cycle; Gas turbine cycle with intercooling; Gas turbine cycle with reheat, regeneration and intercooling, Numerical problems; Jet Propulsion – Introduction to jet propulsion**, G**as turbine cycles for jet propulsions, Working of ram jet engine, Pulse jet engine, Turbo jet engine, Turboprop engine, comparisons of various propulsive devices, Numerical problems.	
UNIT-3	**VAPOUR POWER CYCLES** (CLASSROOM TEACHING)	**9L+4T**
	Introduction; Performance parameters; Carnot vapor power cycle; Rankine cycle; actual vapour power cycle; Comparison of Rankine and Carnot cycles; Mean temperature of heat addition; Steam nozzles - Flow of steam through nozzles, Shape of nozzles, effect of friction, Critical pressure ratio, Supersaturated flow; Methods of improving the thermal efficiency of vapor power plant; Reheat cycle; Ideal and practical regenerative cycle; Reheat-regenerative cycle; feed water heaters; Numerical problems.	
UNIT-4	**RECIPROCATING AIR COMPRESSORS** (CLASSROOM TEACHING)	**9L+4T**
	Introduction; Working principle, p-v diagram and derivation of work input of a single stage reciprocating compressor; Adiabatic, isothermal and mechanical efficiencies; Effect of clearance and derivation of volumetric efficiency, Numerical problems; Multistage compressor; Intercooling, Saving in work, Optimum intermediate pressure, Minimum work for compression; Numerical problems.	
UNIT-5	**REFRIGERATION CYCLES AND PSYCHROMETRY** (ONLINE TEACHING)	**9L+4T**

	Introduction; Units of refrigeration, COP; Reversed Carnot cycle; Vapour compression refrigeration cycle; Deviation of actual cycle from ideal cycle; Effect of change in operating conditions on the performance of vapour compression cycle, Numerical problems; Refrigerants – Selection, Properties of refrigerant; Vapour absorption refrigeration system, Steam jet refrigeration system; Gas cycle refrigeration-Bell Coleman cycle; Numerical problems; Psychrometry: Definitions of terms related to psychrometry – WBT, DBT, DPT, specific humidity, relative humidity, enthalpy, psychrometric chart, psychrometric processes, summer and winter air conditioning, numerical problems.	

TEXT BOOKS

1. **Basic and Applied Thermodynamics,** P.K. Nag, Tata McGraw-Hill Publications, 2nd Edition, 2010.
2. **Applications of Thermodynamics,** V. Kadambi, T R Seetharam and K B Subramanya Kumar, Wiley India Private Limited, 1st Edition, 2019.
3. **Thermodynamics: An Engineering Approach**, Yunus A Cengel and Michael A Boles, McGraw Hill Education (India) Pvt. Limited, 8th Edition, 2016

REFERENCE BOOKS

1. **A Course in Thermal Engineering,** A. Domkundwar, C.P. Kothandaraman, S. Domkundwar, DanpatRai and Co (P) Limited, 2013.
2. **Gas Turbines,** V Ganeshan,Tata McGraw-Hill Publications, 2nd Edition, 2003.
3. **Gas Turbines and Jet Rocket Propulsion**, V.M. Domkundwar, DhanpatRai & Co. (P) Limited, 2nd Edition, 2013.

e-LEARNING RESOURCES

For Videos, Lecture Notes, Visit http:// www.nptel.ac.in

MASSIVE OPEN ONLINE COURSES (MOOCs):

Students are encouraged to visit http:// www.nptel.ac.in (http:// www.swayam.gov.in) and register for the following MOOCs:

1. Concepts of Thermodynamics (12 Week Course; Jan-April/July-Oct)
2. IC Engines and Gas Turbines (12 Week Course; Jan-April)
3. Applied Thermodynamics for Engineers (12 Week Course; July-Oct)

DATA HAND BOOKS AND CHARTS

1. **Thermodynamics Data Hand Book (SI Units),** B T Nijaguna and B S Samaga, Sudha Publications, 2016.
2. **Refrigeration Tables and Charts: SI Units,** C.P. Kothandaraman**,** 4th Edition, New Age International Publishers, 2015.

COURSE OUTCOME (CO)

After the completion of the course, students will be able to:

CO1: *Explain* various thermodynamic processes and air standard power cycles with p-v and T-s diagrams; *derive* expressions of efficiency and mean effective pressure of power cycles; *understand* the measurement of various parameters to *assess* the performance of internal combustion engines (RBTL 1, 2, 3).

CO2: *Describe* the various gas turbine cycles and jet propulsion devices with neat sketches; *solve* related numerical problems (RBTL 1, 2, 3).

CO3: *Understand* and *compare* the Carnot and Rankine vapour power cycles with T-s diagrams; *derive* expressions for efficiency and *solve* related numerical problems (RBTL 1, 2, 3).
CO4: *Describe* the working principle of reciprocating air compressor; *derive* the expressions for its performance and *solve* related numerical problems (RBTL 1, 2, 3).
CO5: *Explain* the vapour compression and gas cycle refrigeration systems with T-s diagrams; *derive* expressions for coefficient of performance and *solve* related numerical problems; *Describe* the various psychrometric processes plotted on a psychrometric chart; *understand* the summer and winter air conditioning systems and *solve* related numerical problems (RBTL 1, 2, 3).
(RBTL: Revised Bloom's Taxonomy Level 1 – Remembering, 2 – Understanding, 3 – Applying, 4 - Analyzing, 5 - Evaluating, 6 - Creating)

MAPPING OF COs WITH POs												
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	2	0	1	2	2	3	3	3	3
CO2	3	3	3	2	0	1	2	2	3	3	3	3
CO3	3	3	2	2	0	1	2	2	3	3	3	3
CO4	3	3	3	2	0	1	2	2	3	3	3	3
CO5	3	3	2	2	0	1	2	2	3	3	3	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										
3. Each full question shall have a maximum of 3 sub-divisions.										

ADMISSION YEAR : 2019-20 ACADEMIC YEAR: 2020-21
SEMESTER : FOURTH

COURSE TITLE : KINEMATICS OF MACHINES		
Sub Code: 18ME45	**No of Credits =4** **L-T-P-SS::3:2:0:0**	**No. of Contact hours/week : 3L+2T** **Total Number of Contact hours : 65**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Basic engineering mathematics**	

COURSE OBJECTIVES:
1) Explain the types of relative motion.
2) Differentiate between Machine, Mechanism, and Structure.
3) Draw the velocity and acceleration diagram of various linkages.
4) Determine the gear parameters and check for interference.
5) Calculate the fixing torque in gear trains.
6) Design the Cam profile for the desired follower motion.

#	CONTENTS	Hrs.
UNIT-1	**INTRODUCTION** (BLENDED TEACHING)	**9L+4T**
	Definitions Link or element, kinematic pairs, degrees of freedom, Grubler's criterion (without derivation), Kinematic chain, mechanism, structure, mobility of mechanism, inversion, machine. **Kinematic chains and inversions -** Inversions of four bar chain; single slider crank chain and double slider crank chain practical applications. **Mechanisms -** Quick return motion mechanisms-drag link mechanism, Whitworth mechanism and crank and slotted lever mechanism. Straight line motion mechanisms Peaucellier's mechanism and Robert's mechanism. Intermittent motion mechanisms -Geneva wheel mechanism and Ratchet and Pawl mechanism. Toggle mechanism, Pantograph, Ackerman steering gear mechanism,. All wheel drive mechanism, power steering, Antilock Braking System.	
UNIT-2	**VELOCITY AND ACCELERATION ANALYSIS OF MECHANISMS (GRAPHICAL METHODS)** (CLASS ROOM TEACHING)	**9L+4T**
	Velocity and acceleration analysis of four bar mechanism, slider crank mechanism and simple mechanisms by vector polygons: relative velocity and acceleration of particles .in a common link, relative velocity and accelerations of coincident particles on separate links- Coriolis component of acceleration. Angular velocity and angular acceleration of links, velocity of rubbing, Numericals.	
UNIT-3	**VELOCITY ANALYSIS BY INSTANTANEOUS CENTER METHOD** (CLASS ROOM TEACHING)	**9L+4T**
	Definition, Kennedy's Theorem, determination of linear and angular velocity using instantaneous center method, Numericals. **KLEIN'S CONSTRUCTION**: Analysis of velocity and acceleration of single slider crank mechanism, Numericals.	
UNIT-4	**GEARS & GEAR TRAINS** (ONLINE TEACHING)	**9L+4T**
	GEARS: Spur gears and its terminology, law of gearing, characteristics of involute action, path of contact, arc of contact, contact ratio of spur, helical, bevel and worm gears, interference in involute gears. Methods of avoiding interference, backlash, comparison of involute and cycloidal teeth, numericals. **GEAR TRAINS:** Simple gear trains, Compound gear trains for large speed reduction, epicyclic gear trains, reverted gear trains Algebraic and tabular methods of finding	

	velocity ratio of epicyclic gear trains. Tooth load and torque calculations in epicyclic gear trains, numericals.	
UNIT-5	**CAMS** (CLASS ROOM TEACHING)	**9L+4T**
	Types of cam and follower. Displacement, velocity and, acceleration time curves for cam profiles, disc cam with reciprocating follower having knife-edge, roller and flat-face follower, disc cam with oscillating roller follower. Follower motions including SHM, uniform velocity, uniform acceleration and retardation and cycloidal motion, Problems.	

TEXT BOOKS:

1. **"Theory of Machines",** Thomas Bevan
2. **"Theory of Machines",** Rattan S.S, Tata McGraw-Hill Publishing Company Ltd., New Delhi, and 3rd edition -2009.
3. **"Theory of Machines",** Sadhu Singh, Pearson Education (Singapore) Pvt. Ltd, Indian Branch New Delhi, 2nd Edi. 2006

REFERENCE BOOKS:

1. **"Theory of Machines & Mechanisms**", J.J. Uicker, G.R. Pennock, J.E. Shigley. OXFORD 3rd Ed. 2009.
2. **Mechanism and Machine theory**, Ambekar, PHI, 2007

Graphical Solutions may be obtained either on the Graph Sheets or on the Answer Book itself.

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Identify the types of Kinematic motion in machines used in everyday life.

CO2: calculate the velocity and acceleration of linkages using graphical, analytical, and vector approaches.

CO3: Analyse the four bar and slider crank mechanism through instantaneous centre method

CO4: Estimate the gear tooth parameters, train value for different types of gear trains.

CO5: Design the cam profile for the desired follower motion for applications such as IC engine valves, machine tools.

MAPPING OF COs WITH POs												
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	1	1	1	3	3	3	0	2
CO2	3	3	2	1	1	1	1	3	3	3	0	2
CO3	3	3	3	1	1	1	1	3	3	3	0	2
CO4	3	3	2	1	2	1	1	3	3	3	0	2
CO5	3	3	3	1	1	1	1	3	3	3	0	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2019-20 ACADEMIC YEAR: 2020-21
SEMESTER : FOURTH

COURSE TITLE : MANUFACTURING PROCESSES LABORATORY - II		
Sub Code:18MEL46	**No of Credits L-T-P-SS :: 0:0:2:0 = 01**	**No. of practical hours/week: 02**
Exam Duration : 03 hours	**CIE Marks: 50**	**Examination Marks : 50**
Pre-requisites	**Elements of Mechanical Engineering, Manufacturing Processes II**	

COURSE OBJECTIVES:
1.To teach the students to produce simple work pieces using a lathe
2. To let students cut teeth on a gear blank using a milling machine

#	CONTENTS	Hours
PART A	**LATHE** 02 models preparation on Turning Machine involving; • Facing - preliminary operation • Plain turning - preliminary operation • Step turning • Taper turning • Knurling • Thread cutting • Drilling • Boring • Internal-Thread-cutting • Eccentric-turning	**16**
PART B	**MILLING MACHINE** Milling Machine - Milling machine tools and operations demonstration Cutting of Gear Teeth – 01 model	**10**

REFERENCE BOOKS:

1. **Production Technology,** R.K.Jain, Khanna Publications, 2003.
2. **Production Technology,** HMT, Tata McGraw Hill, 2001.
3. Manufacturing Technology - Vol. 2, P N Rao,TMH; Third edition (1 May 2013)
4. **Production Technology,** R.K.Jain, Khanna Publications, 2003.
5. Production Technology, P.C. Sharma, S Chand (1 December 2006)

COURSE OUTCOMES: On completion of the course, student should be able to:
CO1: Identify the universal machine tool and prepare models using lathe.
CO2: Able to calculate the number of teeth that can be cut on a given blank and cut gear teeth using a milling machine.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	1	1	2	2	2	3	3	3	2	2
CO2	3	3	1	1	2	2	2	3	3	3	2	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

CONTINUOUS INTERNAL EVALUATION (CIE)

1. CIE has a maximum of 50 marks.
2. CIE Marks is finalized by conducting a test at the end of 12th week of the semester.
3. CIE Marks (50) = Evaluation of Record (30) + Test (20)

SCHEME OF CONTINUOUS INTERNAL EVALUATION (CIE)	
RECORD WRITING	
PART-A	
Lathe tools, operations and model	20 MARKS
PART-B	
Tools, Operations and model on a milling machine	10 MARKS
TOTAL – 1	**30 MARKS**
CIE at the end of 12th week of the semester	
ONE lathe Model from PART A	30 MARKS
ONE model from PART B	10 MARKS
Viva – Voce	10 MARKS
	50 MARKS
TOTAL – 2 = 50/2.5	**20 MARKS**
GRAND TOTAL (TOTAL-1+TOTAL-2)	**50 MARKS**

SCHEME OF SEMESTER END EXAMINATION (SEE)	
One **Lathe Model** from PART A	30 MARKS
ONE **model** from PART B	10 MARKS
Viva – Voce	10 MARKS
TOTAL	**50 MARKS**

ADMISSION YEAR : 2019-20 ACADEMIC YEAR: 2020-21
SEMESTER : FOURTH

COURSE TITLE : MECHANICAL MEASUREMENTS LABORATORY		
Sub Code: 18MEL47	**No of Credits =1** **L-T-P-SS::0:0:2:0**	**No. of practical hours/week: 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 50**
Pre-requisites		

COURSE OBJECTIVES:

1. Calibration of vital tools including micrometer in measurements laboratory
2. Calculate modulus of elasticity of a ductile specimen
3. Measurement of parameters like; Angle, Alignment, Cutting tool forces, Screw thread, Surface roughness and Gear tooth profile

	Contents	**Hrs**
PART A	**MEASUREMENTS**	**12**
	Calibration of Pressure Gauge, Thermocouple, LVDT, Load cell, Micrometer using slip gauges; Determination of modulus of elasticity of a ductile specimen using strain gauges	
PART B	**METROLOGY**	**14**
	Measurement using Optical Projector and Optical Flats, Measurement of angle using Sine bar & bevel protractor, Surface roughness using Mechanical Comparator, gear tooth profile using gear tooth Vernier	

REFERENCE BOOKS:

1. **Mechanical Measurements,** Beckwith Marangoni and Lienhard, Pearson Education, 6th Edition, 2006. (For Measurements Part Only)
2. **Engineering Metrology,** R.K. Jain, Khanna Publishers, 1994
3. **Mechanical Measurements and Metrology,** Dr. T. Chandrasekhar, Subhash Publishers, III Edition, 2009.

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Calibrate various measuring instruments such as Pressure Gauge, Thermocouple, LVDT, Load cell and determination of modulus of elasticity.

CO2: Use Optical Projector, Optical Flats, measurement of angle using Sine bar & bevel protractor, Surface roughness using Mechanical Comparator, gear tooth profile using gear tooth Vernier

MAPPING OF COs WITH POs												
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	1	1	0	2	2	2	3	3	0	2
CO2	3	3	1	1	0	2	2	2	3	3	0	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

CONTINUOUS INTERNAL EVALUATION (CIE)

1.CIE Marks is finalized by conducting a test at the end of 10th week of the semester.
2.CIE Marks (50) = Evaluation of Record (30) + Test (20)

SCHEME OF EXAMINATION (SEE)	
One experiment from PART A	15 MARKS
One experiment from PART B	25 MARKS
Viva – Voce	10 MARKS
TOTAL	50 MARKS

Dr. Ambedkar Institute of Technology, Bengaluru-560 056
SCHEME OF TEACHING AND EXAMINATION from Academic Year 2020-21
B.E Name of the programme
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

V SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	HS	18HS51/52	Management & Entrepreneurship / Intellectual Property Rights	Hu	3	-	--	03	50	50	100	3
2	PC	18ME51	Design of Machine Elements - I	ME	4	0	--	03	50	50	100	4
3	PC	18ME52	Dynamics of Machines	ME	3	0	--	03	50	50	100	3
4	PC	18ME53	Turbomachines	ME	2	2	--	03	50	50	100	3
5	PC	18ME54	Computer Aided Design and Manufacturing	ME	4	0	--	03	50	50	100	4
6	PE	18ME55X	Professional Elective -1	ME	3	0	--	03	50	50	100	3
7	PE	18XXE01	Open Elective -A		3	--	--	03	50	50	100	3
8	PC	18MEL56	Computer Aided Manufacturing Laboratory	ME	--	--	2	03	50	50	100	1
9	PC	18MEL57	Fuel Testing and Internal Combustion Engines Laboratory	ME	--	0	2	03	50	50	100	1
TOTAL					**22**	**2**	**4**	**27**	**450**	**450**	**900**	**25**

10	HS	18HS55	Placement Training	Hu	02	--	--	03	50	-	50	PP/ NP
Note: Hu: Humanities, PC: Professional Core, MC: Mandatory Course												

Course code	**Professional Electives - 1**	**OPEN ELECTIVE –A**
18ME551	Engineering Economics	Students can select any one of the open electives (Please refer to consolidated list of Dr AIT for open electives) offered by any Department. Selection of an open elective is not allowed provided, • The candidate has studied the same course during the previous semesters of the programme. • The syllabus content of open elective is similar to that of Departmental core courses or professional electives. • A similar course, under any category, is prescribed in the higher semesters of the programme. Registration to electives shall be documented under the guidance of Programme Coordinator / Mentor.
18ME552	Composite Materials and Manufacturing	
18ME553	Automobile Engineering	
18ME554	Mechatronics and Microprocessor	
18ME555	Principles of Metal Forming	
18ME556	Experimental Stress Analysis	
	OPEN ELECTIVE – A	
18XXE01		

Dr. Ambedkar Institute of Technology, Bengaluru-560 056
SCHEME OF TEACHING AND EXAMINATION from Academic Year 2020-21
B.E Name of the programme
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

VI SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	HS	18HS61/62	Management & Entrepreneurship / Intellectual Property Rights	Hu	3	--	--	03	50	50	100	3
2	PC	18ME61	Design of Machine Elements - II	ME	3	2	--	03	50	50	100	4
3	PC	18ME62	Heat Transfer	ME	3	2	--	03	50	50	100	4
4	PC	18ME63	Mechanical Vibrations	ME	2	2	--	03	50	50	100	3
5	PE	18ME64X	Professional Elective -2	ME	3	0	--	03	50	50	100	3
6	OE	18XXE02	Open Elective -B		3	--	--	03	50	50	100	3
7	PC	18MEL65	Fluid Mechanics and Machines Laboratory	ME	--	--	2	03	50	50	100	1
8	PC	18MEL66	Heat Transfer Laboratory	ME	--	0	2	03	50	50	100	1
9	MP	18MEP67	Mini-project	ME				03	50	50	100	2
10	INT	18XXI69	Industry Internship	(To be carried out during the intervening vacations of VI / VII semesters)				--				
				TOTAL	**17**	**6**	**4**	**27**	**450**	**450**	**900**	**24**

<table>
<tr><td>10</td><td>HS</td><td>18HS66</td><td>Placement Training</td><td>Hu</td><td>02</td><td>--</td><td>--</td><td>03</td><td>50</td><td>-</td><td>50</td><td>PP/NP</td></tr>
<tr><td colspan="13">Note: PC: Professional core, PE: Professional Elective, OE: Open Elective, MP: Mini-project, INT: Internship.</td></tr>
<tr><td colspan="13"></td></tr>
<tr><td colspan="13">Internship: All the students admitted to III year of BE/B. Tech have to undergo mandatory internship of 4 weeks during the vacations of VI and VII semesters and /or VII and VIII semesters. A University examination will be conducted during VIII semester and prescribed credit are added to VIII semester. Internship is considered as a head of passing and is considered for the award of degree. Those, who do not take-up/complete the internship will be declared as failed and have to complete during subsequent University examination after satisfy the internship requirements.</td></tr>
</table>

<table>
<tr><th>Course code</th><th>Professional Electives - 2</th><th>OPEN ELECTIVE –B</th></tr>
<tr><td>18ME641</td><td>Inspection And Quality Control</td><td rowspan="10">Students can select any one of the open electives (Please refer to consolidated list of Dr AIT for open electives) offered by any Department.
Selection of an open elective is not allowed provided,
• The candidate has studied the same course during the previous semesters of the programme.
• The syllabus content of open elective is similar to that of Departmental core courses or professional electives.
• A similar course, under any category, is prescribed in the higher semesters of the programme.
Registration to electives shall be documented under the guidance of Programme Coordinator / Mentor.</td></tr>
<tr><td>18ME642</td><td>Advanced Welding Processes</td></tr>
<tr><td>18ME643</td><td>Internal Combustion Engines</td></tr>
<tr><td>18ME644</td><td>Production And Operations Management</td></tr>
<tr><td>18ME645</td><td>Finite Element Methods</td></tr>
<tr><td>18ME646</td><td>Fluid Power Control Systems</td></tr>
<tr><td></td><td>OPEN ELECTIVE – B</td></tr>
<tr><td>18XXE02</td><td></td></tr>
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ADMISSION YEAR :	**2018-19**		**ACADEMIC YEAR: 2020-21**
SEMESTER :	**FIFTH**		

COURSE TITLE : DESIGN OF MACHINE ELEMENTS – I		
Sub Code: 18ME51	**No of Credits =04** **L-T-P-SS::4:0:0:0**	**No. of lecture hours/week : 04** **Total Number of Lecture hours : 52**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Mechanics of Materials, Material science and metallurgy**	

COURSE OBJECTIVES:

1. To study basic principles of machine design
2. To acquaint with the concepts of strength design related to various components.
3. To familiarize usage of design data books & various codes of practice.
4. To make conversant with preparation of working design drawings

#	CONTENTS	Hrs
UNIT-1	**INTRODUCTION TO MACHINE DESIGN** (ONLINE TEACHING)	**10**
	Introduction to machine design, Classification, Phase/steps in Machine design process. Design Considerations, Design Method and mechanical Properties and IS coding of various materials, Selection of material from properties and economic aspects. Manufacturing Considerations in Design: Standardization, Interchangeability, limits, fits tolerances and surface roughness, BIS codes, Design consideration for cast, forged and machined parts. Codes and standards, Stress-strain diagrams, Stress analysis, Definitions: normal, shear, biaxial and tri axial stresses, Stress tensor, Principal and Shear Stresses and their directions.	
UNIT-2	**DESIGN FOR STATIC STRENGTH & STRESS CONCENTRATION** (BLENDED TEACHING)	**10**
	DESIGN FOR STATIC STRENGTH: Static loads and factor of safety, Theories of failure: Maximum normal and shear stress theories, Maximum strain theory, Strain and Distortion energy theories. Failure of brittle and ductile materials. **STRESS CONCENTRATION:** Definition, Reason for occurrence, Methods to reduce, Stress concentration factor, charts and static loads, compound stress concentration factors, Design of stress concentrated members under various loads and Numerical problems.	
UNIT-3	**DESIGN FOR FATIGUE STRENGTH & IMPACT STRENGTH** (CLASSROOM TEACHING)	**10**
	DESIGN FOR FATIGUE STRENGTH: Introduction- S-N Diagram, Low and High cycle fatigues, Endurance limit, fatigue failure prevention. Modifying factors: Load, size, surface, causes for SEF and effects of SEF, Fluctuating stresses, Soderberg and Goodman, Gurber relation, stresses due to combined loading, cumulative fatigue damage. Problems on design of members for finite & infinite life subjected to individual & combined loading. Cumulative damage in fatigue. **IMPACT STRENGTH:** Introduction, Impact stresses due to axial, bending and torsional loads, effect of inertia. Numerical problems**.**	
UNIT-4	**DESIGN OF SHAFTS, KEYS & COUPLINGS** (CLASSROOM TEACHING)	**10**
	DESIGN OF SHAFTS: Types, Design of solid & hollow shaft on strength and rigidity basis with steady loading subjected to pure torsion with steady loading, Design of shafts carrying pulleys & gears (Combined loading). ASME codes for power transmission shafting, shafts under fluctuating loads and combined loads and Numerical problems.	

	KEYS: Types of Keys and their selection based on shafting condition, key ways, splines **SHAFT COUPLINGS**: Introduction, classification, advantages, and applications of Couplings: design of Rigid and flexible couplings, Flange coupling, Bush and Pin type coupling and Oldham's coupling and Numerical problems.	
UNIT-5	**RIVETED, WELDED AND BOLTED JOINTS** (BLENDED TEACHING)	**12**
	RIVETED JOINTS: Types, rivet materials, Modes of failures of riveted joints, Strength Equations – efficiency of riveted joints, Joint Efficiency, Boiler Joints, Lozenge Joints, Riveted Brackets, Eccentrically riveted joints and Numerical problems. **WELDED JOINTS:** Types, Strength of butt and fillet welds, eccentrically loaded welded joints and Numerical problems. **BOLTED JOINTS:** Design of bolts with pre-stresses – Design of joints under eccentric loading	

TEXT BOOKS:

1. Mechanical Engineering Design, Joseph E Shigley and Charles R. Mischke. McGraw Hill International edition, 6^{th} Edition 2009.
2. Design of Machine Elements**,** V.B. Bhandari, TMH, New Delhi, 2^{nd} Ed. 2007.

DESIGN DATA HANDBOOK:

1. Design Data Hand Book, K. Lingaiah, McGraw Hill, 2^{nd} Ed.
2. Data Hand Book, K. Mahadevan and Balaveera Reddy, CBS Publication
3. Design Data Hand Book, H.G. Patil, Shri Shashi Prakashan, Belgaum.

REFERENCE BOOKS:

1. **Machine Design,** Robert L. Norton, Pearson Education Asia, 2001.
2. Design of Machine Elements, M. F. Spotts, T. E. Shoup, L. E. Hornberger, S. R. Jayram and C. V. Venkatesh, Pearson Education, 2006.
3. Machine Design, Hall, Holowenko, Laughlin (Schaum's Outlines series) Adapted by S.K. Somani, TMH, New Delhi, Special Indian Edition, 2008.
4. Fundamentals of Machine Component Design, Robert C. Juvinall and Kurt M Marshek, Wiley India Pvt. Ltd., New Delhi, 3^{rd} Edition, 2007.
5. Fundamentals of Machine Elements - Hawrock, Jacobson Mcgraw Hill
6. Machine Design - Patel, Pandya, Sikh, Vol. - I & II, C.
7. Fundamentals of Machine Elements B.J. Hamrock, and S.R. Schmid TMH.
8. The Mechanical Design Process. D.G. Ullman, TMH, New Delhi, 2008.

COURSE OUTCOMES: On completion of the course, students will be able to:

CO1: Demonstrate understanding of various design considerations

CO2: Apply basic principles of machine design

CO3: Design machine elements on the basis of strength concept

CO4: Use design data books and various standard codes of practices and acquire skill in preparing production drawings pertaining to various designs.

CO5: Successfully design machine components for suitable applications.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	2	2	3	2	3	1	3	3
CO2	2	3	3	2	3	3	3	1	2	3	3	2
CO3	3	3	2	3	3	3	3	1	3	2	3	2
CO4	3	3	2	3	3	2	3	2	1	2	3	3
CO5	3	3	3	3	2	2	3	2	3	1	3	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										
3. Design Data Hand Book is permitted										

ADMISSION YEAR : 2018-19 **ACADEMIC YEAR: 2020-21**
SEMESTER : FIFTH

COURSE TITLE : DYNAMICS OF MACHINES		
Sub Code: 18ME52	**No of Credits =03** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**KOM**	

COURSE OBJECTIVES:

1. Draw and analyze free body diagram for multiple forces applied on static members of four bar chain and slider mechanism.
2. Design the size of the flywheel for the excess energy storage and retrieval.
3. The terms slip and creep in belt drives.
4. Determine the value of balancing mass for the system.
5. Define sensitivity, isochronous, hunting, controlling force with respect to governors.
6. Analyses the effect of gyro on automobile, ship, Aeroplanes.

UNITS	CONTENTS	Hrs
UNIT-1	**STATIC FORCE ANALYSIS** (CLASS ROOM TEACHING)	**08**
	Introduction, Static equilibrium, Equilibrium of two and three force members. Members with two forces and torque, Free body diagrams, Static force analysis of simple mechanisms. Principle of virtual work, Numericals.	
UNIT-2	**DYNAMIC FORCE ANALYSIS** (CLASS ROOM TEACHING)	**07**
	Dynamic force analysis, motion and Inertia: Alembert's principle, Inertia force and inertia torque, Inertia forces on a four bar mechanism, Numericals.	
UNIT-3	**FRICTION & BELT DRIVES** (BLENDED TEACHING)	**08**
	Friction: Definitions: Types of friction: laws of solid friction, coefficient friction. **Belt dives:** Initial tension in the belt, ratio of belt tensions, Effect of Centrifugal tension, power transmitted by Belt thickness and width calculations, V-Belts ,Rope Drives (circular belts) Numericals.	
UNIT-4	**BALANCING OF ROTATING and RECIPROCATING MASSES** (BLENDED TEACHING)	**08**
	Balancing Of Rotating Masses: Static and dynamic balancing. Balancing of single rotating mass in same plane and in different planes. Balancing of several rotating masses in same plane and in different planes, Numericals. **Balancing Of Reciprocating Masses:** Inertia effect of crank and connecting rod, single cylinder engine, balancing in multi cylinder-inline engine (primary & secondary forces), V-type engine; Numericals.	
UNIT-5	**GOVERNORS & GYROSCOPES** (BLENDED TEACHING)	**08**
	Governors: Types of governors; force analysis of Porter and Hartnell governors - Controlling force, stability, sensitiveness, isochronism, effort and power, Numericals. **Gyroscopes:** Vectorial representation of angular motion, gyroscopic couple. Effect of gyroscopic couple on the movement of plane disc, aero plane, stability of two wheeler and four wheeler taking a turn, Numericals.	

TEXT BOOKS:

1. Theory of Machines, Rattan S.S. Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition, 2009.

2. Theory of Machines, Sadhu Singh, Pearson Education. 2nd edition. 2007.

REFERENCE BOOKS:

1. Theory of Machines & Mechanisms, J.J. Uicker, G.R. Pennock, J.E. Shigley. Oxford 3rd edition. 2009

2. Mechanism and Machine Theory, A.G. Ambekar PHI, 2007.

COURSE OUTCOMES: On completion of the course, students will be able to:

CO1: Illustrate basic concept of static forces of equilibrium in a mechanism.

CO2: Illustrate basic concept of dynamic forces of equilibrium in a mechanism and design a flywheel

CO3: Characterize the operation of bearings and belt drives and design them for power transmission.

CO4: Analyze and understand concept of static and dynamic balancing of rotating and reciprocating masses in engine.

CO5: Analyze and understand working Principles of different types of governors and Gyroscopic effects on the mechanical systems

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	1	2	2	2	1	2	3	2	1
CO2	3	2	2	1	2	2	2	1	2	3	2	1
CO3	3	2	2	1	2	2	2	1	2	3	2	1
CO4	3	2	2	1	2	2	2	1	2	3	2	1
CO5	3	2	2	1	2	2	2	1	2	3	2	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2018-19 **ACADEMIC YEAR: 2020-21**
SEMESTER : FIFTH

COURSE TITLE : TURBOMACHINES		
Sub Code: 18ME53	**No of Credits : L-T-P-SS 2:2:0:0 =3**	**No. of lecture hours/week : 04** **Total Number of Lecture hours : 52**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Basic thermodynamics, Fluid mechanics**	

COURSE OBJECTIVES :

1. To outline the working principle of turbo machines with examples and classify turbomachines and describe the energy transfer mechanism of turbo machines.
2. To understand the thermodynamics of flow and apply dimensional analysis and similarity laws for conducting model tests.
3. To explain the functioning of radial flow and axial flow turbo machines such as centrifugal pumps, compressors, steam, gas and hydraulic turbines
4. To demonstrate the effect of important variables affecting the output of turbo machines.
5. To analyze a given problem, apply the fundamental knowledge to solve the problems.
6. To estimate and evaluate unknown parameters and predict the performance of turbo machines.

#	**CONTENTS**	**Hrs.**
UNIT-1	**INTRODUCTION AND DIMENSIONAL ANALYSIS** (BLENDED TEACHING)	**10L+2T**
	Introduction: Definition of a turbo machine; parts of a turbo machine; comparison with positive displacement machine; classification of Turbomachines. **Thermodynamics of fluid flow:** Application of first and second law of thermodynamics to turbo machines; Efficiencies of turbo machines; Static and Stagnation states; Overall isentropic efficiency, stage efficiency (their comparison) and polytropic efficiency for both compression and expansion processes; Reheat factor for expansion process; Simple numerical problems on stage efficiency and polytropic efficiency. **Dimensional Analysis:** Introduction, derived quantities, dimensions of physical quantities, dimensional homogeneity, Rayleigh's method, Buckingham □ theorem, dimensionless numbers, and similitude, types of similitude, dimensional analysis and similarity studies. Numerical problems.	
UNIT-2	**GENERAL ANALYSIS OF RADIAL AND AXIAL FLOW TURBOMACHINES** (CLASSROOM TEACHING)	**8L+2T**
	Energy transfer in a turbo machine - Euler turbine equation; alternate form of Euler turbine equation (components of energy transfer); degree of reaction, utilization factor and relationship between them. **General analysis of radial flow turbo machines (turbines and pumps)** - Effect of blade discharge angle on their performance; Theoretical head-capacity relationship; Numerical problems. **General analysis of axial flow turbines** – utilization factor, degree of reaction, relationship between utilization factor and blade speed ratio; Maximum utilization factor and optimum blade speed ratio for impulse and reaction axial flow turbines; General analysis of axial flow compressors and pumps – general expression for energy transfer and degree of reaction; Numerical problems.	
UNIT-3	**STEAM TURBINES** (CLASSROOM TEACHING)	**8L+2T**
	Introduction; Different efficiencies; Analysis of single stage impulse (De Laval) turbine; Impulse staging and need for compounding; Analysis of velocity compounded impulse	

	(Curtis) turbine; Analysis of Impulse-reaction (Rateau) turbine; Reheat factor for multi stage turbine; Numerical problems.	
UNIT-4	**HYDRAULIC TURBINES** (CLASSROOM TEACHING)	**8L+2T**
	Introduction; Classification; Different heads and efficiencies; Pelton turbine-velocity triangles; Francis turbine-velocity triangles, runner shapes for different blade speeds; function of a draft tube, types of draft tube; Kaplan and Propeller turbines – velocity triangles and analysis; Related numerical problems; Specific speed and its significance; Unit quantities and their uses; Characteristic curves of hydraulic turbines; Numerical Problems.	
UNIT-5	**CENTRIFUGAL PUMPS AND COMPRESSORS** (ONLINE TEACHING)	**8L+2T**
	Centrifugal pumps –Introduction, Main parts of a centrifugal pump; Work done; Definitions of heads and efficiencies; minimum speed for starting; Multistage centrifugal pump; Specific speed; Priming; Characteristic curves; Cavitation; Thoma's cavitation factor; Maximum suction lift; Net positive suction head; Related numerical problems: Centrifugal compressors-Introduction; Work done; Overall pressure ratio developed; Pressure ratio in terms of ϕ_s, ϕ_p, ϕ_w; Compressibility and pre-whirl; Diffuser design; Surging; Numerical problems.	

TEXT BOOKS

1. **A Textbook of Turbo Machines**, Dr M S Govindegowda and Dr A M Nagaraja, 8th Edition, M M Publishers, 2014

2. **Turbo Machines**, Dr. N. Krishnamurthy, Sunstar Publisher, 2nd Edition, 2015.

3. **A Textbook of Fluid Mechanics and Hydraulic Machines (SI Units)**, Dr. R.K. Bansal, Laxmi Publications (P) Limited, Revised 9th Edition, 2010.

REFERENCE BOOKS

1. **An introduction to energy conversion, Vol. III – Turbomachinery**, V. Kadambi and Manohar Prasad, 2nd Edition, New Age International Publishers (P) Limited, 2011.

2. **Principles of turbomachinery**, D. G. Shepherd, MacMillan Company, 1964.

4. **Turbomachines**, B.U. Pai, Wiley Precise Textbook Series, 2014.

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										
3. Each full question shall have a maximum of 3 sub-divisions.										

COURSE OUTCOME (CO): After the completion of the course, students will be able to:
CO1: *Explain* the fundamentals of energy transfer in turbo machines with the application of first and second laws of thermodynamics; *Understand* the dimensional analysis and model studies applied to turbomachines; and *solve* related numerical problems (RBTL 1, 2, 3)
CO2: *Analyse* the radial flow and axial flow turbines and *solve* related numerical problems (RBTL 1, 2, 3).
CO3: *Classify* and *analyse* the various types of steam turbines and *solve* related numerical problems (RBTL 1, 2, 3).
CO4: *Classify* and *analyse* the various types of hydraulic turbines and *solve* related numerical problems (RBTL 1, 2, 3).
CO5: *Classify* and *analyse* the various types of centrifugal pumps and compressors and *solve* related numerical problems (RBTL 1, 2, 3)
(RBTL: Revised Bloom's Taxonomy Levels; 1 – Remembering, 2 – Understanding, 3 – Applying, 4 - Analyzing, 5 - Evaluating, 6 - Creating)

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	2	1	1	1	1	1	1	1
CO2	3	3	3	1	2	1	1	1	1	2	1	1
CO3	3	3	2	1	1	1	1	1	1	2	1	1
CO4	3	3	3	1	2	1	1	1	1	2	1	1
CO5	3	3	2	1	2	1	1	1	1	3	1	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

ADMISSION YEAR : 2018-19 ACADEMIC YEAR: 2020-21
SEMESTER : FIFTH

COURSE TITLE : COMPUTER AIDED DESIGN AND MANUFACTURING		
Sub Code: 18ME54	**No of Credits =04** **L-T-P-SS::4:0:0:0**	**No. of lecture hours/week : 04** **Total Number of Lecture hours : 52**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Manufacturing process**	

COURSE OBJECTIVES:

1. Describe the importance of computers role of CAD/CAM in modern design and manufacturing
2. Comprehend and solve the basic mathematical elements of Computer Graphics.
3. Effective learning of NC & CNC technology and create simple CNC programs for machining operations.
4. To impart the use of CAD and CAM in the design and production preparation process.
5. Demonstrate the concept, configurations and features of Robotics along with its applications.

Sl. No.	CONTENTS	Hrs
UNIT-1	**INTRODUCTION** (ON-LINE TEACHING)	**10**
	Role of computers in design and manufacturing influence of computers in manufacturing environment. Product cycle in convention to computerized manufacturing environment. Introduction to CAD. Introduction to CAM. Advantages and disadvantages of CAD and CAM, Types of surface generation and its applications. Hardware for CAD: Design Workstation, Graphics Terminal - Image generation and maintenance techniques (CRT, LCD, LED), Colour generation in graphic.	
UNIT-2	**GEOMETRIC TRANSFORMATIONS IN COMPUTER GRAPHICS** (BLENDED TEACHING)	**10**
	Software configuration of a graphic system. Function of graphics package, Elements of Solid Modeling, wire frame and solid modeling, CAD/CAM integration. Desirable modeling facilities and transformation. Introduction to exchange of modeling data – basic features of IGES, STEP, DXF, DMIS. SOLID MODELLING – Boundary Representation Cubic splines and Bezier curves and its characteristics, simple problems on Hermite Cubic splines and Bezier curves, concept of B-splines and its advantages.	
UNIT-3	**NC, CNC, DNC TECHNOLOGIES** (ON-LINE TEACHING)	**11**
	NC, CNC, DNC, modes. NC element, advantages and limitations of NC, CNC. Functions of computer in DNC. CNC tooling: Turning tool geometry, milling tooling system, tool presetting. ATC, work holding. Operational features of CNC machine; CNC Technology (Machine Spindle, Drives, Feedback devices etc.)	
UNIT-4	**CNC MACHINING CENTERS** (BLENDED TEACHING)	**11**
	Introduction to CNC, elements of CNC, CNC machining centers, part programming, fundamental steps involved in development of part programming for milling and turning. Canned Cycles (Stock Removal, Threading, Grooving, Parting Off, Contour, Drilling, Face Milling, End Milling), Preparing the Process chart	

UNIT-5	**INTRODUCTION TO ROBOTICS** (BLENDED TEACHING)	**10**
	Introduction, robot configuration, robot motion, programming of robots, end effectors work cell, control and interlock, sensor, robot applications. Kinematic Analysis – Direct and Inverse Kinematic analysis, numerical problems.	

REFERENCE BOOKS

1. **Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM)** by MikellGroover, Pearson Education INC, Fifth Impression, 2008.
2. **CAD/CAM** by P N Rao, Tata McGraw Hill, Sixth Reprint, 2006.
3. **CAD/CAM** by Ibrahim Zied, Tata McGraw Hill, Fourth Reprint, 2008.

COURSE OUTCOMES: On completion of the course, students will be able to:

CO1: Understand the possible applications of the CAD/CAM systems in structure analysis, optimize and virtual engineering.

CO2: Demonstrate the basic fundamentals that are used to create, manipulate and analyze Geometric models in a computer graphics.

CO3: Explain the basic concepts, features of NC, CNC, DNC machines.

CO4: Explain the features of machining centres and able to write part programmes for different operations and work parts.

CO5: Appraise the functions of Robotic configurations, sensors, end effectors, Programming and able to analyze kinematic and dynamic motion of robot.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	2	1	1	1	1	2	1	1
CO2	3	3	2	1	1	1	1	1	1	2	1	1
CO3	3	3	3	1	2	1	1	1	1	2	1	1
CO4	3	3	2	1	2	1	1	1	1	2	1	1
CO5	3	2	3	2	3	1	1	1	1	2	2	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR :	**2018-19**	**ACADEMIC YEAR: 2020-21**
SEMESTER :	**FIFTH**	

COURSE TITLE : ENGINEERING ECONOMICS (PROFESSIONAL ELECTIVE - 1)		
Sub Code: 18ME551	**No of Credits =03** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 100**
Pre-requisites	**Engineering mathematics**	

COURSE OBJECTIVES:

1. Helping decision making
2. Calculation of interest
3. Arriving at break-even point
4. Feasibility study from economic point of view
5. Preparation of budget
6. Understanding financial statements
7. Arriving at the product cost.

UNIT	CONTENTS	Hrs.
UNIT-1	**INTRODUCTION (**CLASS ROOM TEACHING)	**07**
	Elements of engineering economics, engineering decision- makers, engineering and economics, problem solving and decision making, intuition and analysis, tactics and strategy. Engineering economic decision, maze. Law of demand and supply, law of returns, interest and interest factors: interest rate, simple interest, compound interest, cash - flow diagrams, personal loans and EMI payment, exercises and discussion.	
UNIT-2	**PRESENT-WORTH COMPARISONS: (**CLASS ROOM TEACHING)	**08**
	Conditions for present worth comparisons, basic present worth comparisons, present-worth equivalence, net present-worth, assets with unequal lives, infinite lives, future-worth comparison, pay-back comparison, exercises, discussions and problems.	
UNIT-3	**RATE-OF-RETURN CALCULATIONS AND DEPRECIATION**: **(**CLASS ROOM TEACHING)	**07**
	Rate of return, minimum acceptable rate of return, IRR, IRR misconceptions, cost of capital concepts. Causes of depreciation, basic methods of computing depreciation charges, tax concepts, and corporate income tax.	
UNIT-4	**INTRODUCTION, SCOPE OF FINANCE, FINANCE FUNCTIONS:** **(**CLASS ROOM TEACHING)	**08**
	Statements of financial information: introduction, source of financial information, financial statements, balance sheet, profit and loss account, relation between balance sheet and profit and loss account. Simple Numericals. **FINANCIAL RATIO ANALYSIS**: Introduction, nature of ratio analysis, liquidity ratios, leverage ratios, activity ratios, profitability ratios, evaluation of a firm's earning power. Comparative statements analysis. Simple Numericals.	
UNIT-5	**FINANCIAL AND PROFIT PLANNING** (BLENDED TEACHING)	**09**
	Introduction, financial planning, profit planning, objectives of profit planning, essentials of profit planning, budget administration, type of budgets, preparation of budgets, advantages, problems and dangers of budgeting. Introduction to bench marking of manufacturing operation. **ESTIMATING AND COSTING:** Components of costs such as direct material costs, direct labor costs, fixed over-heads, factory cost, administrative overheads, first cost, marginal cost, selling price, estimation for simple components.	

TEXT BOOKS:
1. Engineering Economy, Riggs J.L., McGraw Hill, 2002
2. Engineering Economy, Thuesen H.G. PHI, 2002

REFERENCE BOOKS:
1. Engineering Economy, Tarachand, 2000.
2. Industrial Engineering and Management, OP Khanna, Dhanpat Rai & Sons. 2000
3. Financial Management, Prasanna Chandra, TMH, 2004
4. Financial Management, IM PANDEY, Vikas Publisahing House, 2002

COURSE OUTCOMES: At the end of the course the student will be able to:
CO1: Take the right financial decision.
CO2: Help in calculating the financial factors.
CO3: Arrive at feasibility study of the project.
CO4: Training the students for preparing the budget.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	2	1	1	1	1	2	1	1
CO2	3	3	2	3	1	1	1	2	1	1	1	2
CO3	3	3	3	2	2	1	1	1	2	1	1	1
CO4	3	3	3	1	2	1	1	1	1	2	1	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2018-19 **ACADEMIC YEAR: 2020-21**
SEMESTER : FIFTH

COURSE TITLE : COMPOSITE MATERIALS & MANUFACTURING (PROFESSIONAL ELECTIVE –1)		
Sub Code: 18ME552	**No of Credits =3** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**

COURSE OBJECTIVES:

1. This subject introduces different types of composite materials to the students
2. Students are introduced to different properties of composite materials
3. Students get to know the different applications of these materials

UNIT	CONTENTS	Hrs.
UNIT-1	**INTRODUCTION TO COMPOSITES** (BLENDED MODE)	**08**
	Fundamentals of composites - need for composites – Enhancement of properties - classification of composites – Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Reinforcement – Particle reinforced composites, Fibre reinforced composites. Applications of various types of composites.	
UNIT-2	**PROCESSING OF POLYMER MATRIX COMPOSITES** (BLENDED MODE)	**08**
	Polymer matrix resins – Thermosetting resins, thermoplastic resins – Reinforcement fibres – Rovings – Woven fabrics – Non woven random mats – various types of fibres. PMC processes - Hand lay-up processes – Spray up processes – Compression moulding – Reinforced reaction injection moulding - Resin transfer moulding – Pultrusion – Filament winding – Injection moulding. Fibre reinforced plastics (FRP), Glass fibre reinforced plastics (GFRP).	
UNIT-3	**PROCESSING OF METAL MATRIX COMPOSITES** (BLENDED MODE)	**08**
	Characteristics of MMC, Various types of Metal matrix composites Alloy vs. MMC, Advantages of MMC, Limitations of MMC, Metal Matrix, Reinforcements – particles – fibres. Effect of reinforcement - Volume fraction – Rule of mixtures. Processing of MMC – Powder metallurgy process - diffusion bonding – stir casting – squeeze casting	
UNIT-4	**PROCESSING OF CERAMIC MATRIX COMPOSITES** (BLENDED MODE)	**08**
	Engineering ceramic materials – properties – advantages – limitations – Monolithic ceramics - Need for CMC – Ceramic matrix - Various types of Ceramic Matrix composites- oxide ceramics – non oxide ceramics – aluminium oxide – silicon nitride – reinforcements – particles- fibres- whiskers. Sintering - Hot pressing – Cold isostatic pressing (CIPing) – Hot isostatic pressing (HIPing).	
UNIT-5	**ADVANCES IN COMPOSITES** (BLENDED MODE)	**07**
	Carbon / carbon composites – Advantages of carbon matrix – limitations of carbon matrix Carbon fibre – chemical vapour deposition of carbon on carbon fibre perform. Sol gel technique. Composites for aerospace applications.	

TEXT BOOKS

1. Mathews F.L. and Rawlings R.D., Composite materials: Engineering and Science, Chapman and Hall, London, England, 1st edition, 1994.
2. Chawla K.K., Composite materials, Springer – Verlag, 1987
3. M. Balasubramanian, Composite materials and Processinng, CRC Press, 2014

REFERENCE BOOKS

1. Clyne T.W. and Withers P.J., Introduction to Metal Matrix Composites, Cambridge University Press, 1993.
2. Strong A.B., Fundamentals of Composite Manufacturing, SME, 1989.
3. Sharma S.C., Composite materials, Narosa Publications, 2000.
4. Short Term Course on Advances in Composite Materials, Composite Technology Centre, Department of Metallurgy, IIT- Madras, December 2001.
5. Manoj Kumar Buragohain, Composite Structures: Design, Mechanics, Analysis, Manufacturing, and Testing; CRC Press, 2017
6. Srinivasan K; Composite Material: Production Properties Testing; Narosa Publishers; 2009.
7. Autar K Kaw, Mechanics of Composite Materials, CRC, Taylor & Francis Group, 2006.
8. R.K.Everret & R.J. Arsenault Metal matrix composite Academic press.

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Appreciate the wonder material i.e., composites

CO2: Understand the various processing methods of polymer matrix composites

CO3: Enhance awareness on intricate knowledge on metal matrix composites

CO4: Familiarize with the basics of ceramic matrix composites processing

CO5: Evaluate the role of advanced composites usage in aerospace

MAPPING OF COs WITH POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	1	2	2	1	2	2	0	3
CO2	3	3	3	1	1	2	2	1	2	2	0	3
CO3	3	3	3	1	1	2	2	1	2	2	0	3
CO4	3	3	3	1	1	2	2	1	2	2	0	3
CO5	3	3	3	1	1	2	2	1	2	2	0	3

Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	

1. Two full questions (each of 20 Marks) are to be set from each unit.
2. Student shall answer five full questions selecting one full question from each unit.

ADMISSION YEAR :	**2018-19**	**ACADEMIC YEAR: 2020-21**
SEMESTER :	**FIFTH**	

COURSE TITLE : AUTOMOBILE ENGINEERING (PROFESSIONAL ELECTIVE – 1)		
Sub Code: 18ME553	**No of Credits =03** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	Elements of Mechanical Engineering, Basic and Applied Thermodynamics and Heat Engines	

COURSE OBJECTIVES:

1. To describe the basic systems and components of Automobiles and to analyze Engines, other power generation modes and its allied mechanisms.
2. To emphasize hybrid-electric and electric powertrains, focusing on experimental characterization.
3. To emphasize on encompasses the analysis, design and synthesis of gears and power transmission systems for improved efficiency.
4. To emphasize on Batteries and energy storage, Charging stations, Requirements for interfacing, Connection of sensors/actuators To emphasize on steering geometry, and suspension systems.
5. The efficient control of the braking systems, automotive emission control systems and emission standards.

UNIT	CONTENTS	Hrs.
UNIT-1	**ENGINE COMPONENTS, VALVE AND PORT TIME MECHANISMS, AUTOMOTIVE PROPULSION SYSTEMS , ENERGY CONVERSION AND STORAGE**	**08**
	Spark Ignition (SI) & compression Ignition (CI) engines, cylinder arrangements and their relative merits, liners, piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve and port timing diagrams. **Automotive Propulsion Systems:** Internal combustion engines, hybrid-electric and electric powertrains, focusing on experimental characterization. **Energy Conversion and Storage** covers fundamental and applied research for improving the efficiency of conversion, recovery and storage of primary energy for automotive applications, for instance electrochemical energy converters (fuel cells), waste heat recovery systems based upon thermodynamic cycles or solid-state conversion devices, or electrochemical storage technologies (batteries and super capacitors).	
UNIT-2	**VEHICLE DYNAMICS, SMART MATERIALS, STRUCTURES AND ALTERNATIVE FOSSIL FUEL OPTIONS**	**07**
	Encompasses the analysis, design and synthesis of gears and power transmission systems for improved efficiency, reduced noise and vibrations, as well as the study of complex acoustic sources and transmission paths, techniques for passive and active noise control and diagnostics. Other relevant topics include the study of chassis and vehicle dynamics, and driver assistance systems for efficient and safe mobility. **Smart Materials, Structures and** Encompasses topics related to the design and control of smart materials and devices that compose sensors, actuators and structures for automotive applications; the	

	analysis of aerodynamic flow control systems for road vehicles for reducing drag forces, and advanced manufacturing, lightweight materials and multi-material joining processes. Alternative fossil fuel options, Electrified automotive transportation for the twenty-first century, Industrial and policy background, Categorizing electrified vehicles by "electrification level", Efficiency improvements in ICEs,	
UNIT-3	**IGNITION SYSTEMS, ADVANCED AUTOMOTIVE SYSTEMS, PRINCIPLES AND APPLICATIONS OF SENSOR**	**07**
	Ignition Systems: Battery, magneto, Electronic and automatic ignition systems. **Advanced automotive systems**: hybridization and electrification, Categories of hybridization, Clean petroleum enhancements, Battery Electric Vehicles (BEVs), Electric Motors for Vehicle Applications, Batteries and energy storage, Charging stations, , **Principles And Applications Of Sensor:** Some general statements, Definition of sensors and actuators, Classification of Sensors and Actuators, Sensing and actuating strategies, Requirements for interfacing, Connection of sensors/actuators	
UNIT-4	**DRIVE TO WHEELS**	**08**
	Propeller shaft and universal joints, Hotchkiss and torque tube drives, differential, rear axle, different arrangements of fixing the wheels to rear axle, steering geometry, camber, king pin inclination, included angle, castor, toe in & toe out, condition for exact steering, steering gears, power steering, general arrangements of links and stub axle, over steer, under steer and neutral steer, numerical problems. **Suspension springs:** Requirements, Torsion bar suspension systems, leaf spring, coil spring, independent suspension for front wheel and rear wheel. Air suspension system.	
UNIT-5	**BRAKES AND AUTOMOTIVE EMISSION CONTROL SYSTEMS**	**09**
	Brakes: Types of brakes, mechanical compressed air, vacuum and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disk & drum brakes, antilock braking systems, purpose and operation of antilock-braking system, ABS hydraulic unit, rear-wheel antilock. **Automotive emission control systems:** Automotive emission controls, controlling crankcase emissions, controlling evaporative emissions, cleaning the exhaust gas, controlling the air-fuel mixture, controlling the combustion recirculation, treating the exhaust gas, air-injection system, air-aspirator system, catalytic converter, emission standards- euro and bharath norms.	

TEXT BOOKS

1. Automobile Engineering, Vol I and II, Kirpal Singh, 2002.
2. Automotive mechanics, William H Crouse & Donald L Anglin, 10thEd.TMH 2007
3. Advanced Automotive Systems, Electrification, and an Overview of Relevant Policy Concerns by Josipa G. Petrunic 11th Ed, 2014

REFERENCE BOOKS:

1. Automotive mechanics: Principles and Practices, Joseph Heitner
2. Fundamentals of Automobile Engineering, K.K.Ramalingam, Scitech Pub. Pvt.Ltd.
3. Automobile Engineering, R. B. Gupta, Satya Prakashan, 4th edn. 1984.

COURSE OUTCOMES: On completion of the course, student should be able to:
CO1: Have in depth knowledge on various engine components, cooling, lubrication systems, material choice, cetane and octane numbers.
CO2: Understand the driving wheel systems, to know propeller shaft, universal joints, steering mechanism and suspension systems.
CO3: Understand the ABS automotive emission control, emission standards and bharath norms.
CO4: To understand mixture requirements for I.C, S.I and C.I engines, working principle of superchargers and turbo chargers.
CO5: Understand ignition systems, clutches mechanisms, gear box principle of automatic transmission system, numerical problems on gear ratio. power trains and gear.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	1	0	2	2	2	2	2	0	3
CO2	3	2	2	1	0	2	2	2	2	2	0	3
CO3	3	2	2	1	0	2	2	2	2	2	0	3
CO4	3	2	2	1	0	2	2	2	2	2	0	3
CO5	3	2	2	1	0	2	2	2	2	2	0	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR :	**2018-19**	**ACADEMIC YEAR: 2020-21**	
SEMESTER :	**FIFTH**		

COURSE TITLE : MECHATRONICS AND MICROPROCESSORS (PROFESSIONAL ELECTIVE – 1)		
Sub Code: 18ME554	**No of Credits =03** **L-T-P-SS:3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites		

Course objective:

1. Substantiate the need for interdisciplinary study in technology education.
2. Understand the evolution and development of Mechatronics as a discipline.
3. Define various types of transducers used and understand analog to digital converter and vice versa.
4. Applications of microprocessors in various systems and to know the functions of each Element.
5. Describe the operation of mechanical, electrical pneumatic and hydraulic actuators.
6. Identify main parts, hardware forms and internal architecture of PLC.

#	CONTENTS	Hrs
UNIT-1	**INTRODUCTION TO MECHATRONIC SYSTEMS** (ONLINE TEACHING)	**08**
	Measurement and control systems Their elements and functions, Microprocessor based controllers-engine management system, automatic camera and automatic washing machine, Mechanical components in mechatronics, force, friction and lubrication, materials, mechanical behaviour of materials, mechanisms used in mechatronics, lever and four bar mechanisms, bearing, belt, chain, cam, slider crank, clutches etc.	
UNIT-2	**REVIEW OF TRANSDUCERS AND SENSORS** (BLENDED MODE TEACHING)	**08**
	Definition and classification of transducers. Definition and classification of sensors. Principle of working of and applications of light sensors, proximity sensors – magnetic switch, eddy current type, pneumatic type, ultrasonic type and Hall effect sensors, Computing elements in mechatronics, analog computer, timer, analog to digital converter, digital to analog converter, digital computer, microprocessor and its architecture, micro-controllers, programming logic controllers, their basic structures, mnemonics.	
UNIT-3	**ELECTRICAL ACTUATION SYSTEMS:** (CLASS ROOM TEACHING)	**08**
	Electrical systems, Mechanical switches, solid-state switches, solenoids, DC & AC motors, Stepper motors and their merits and demerits. Signal Conditioning: Introduction to signal conditioning. The operational amplifier.	
UNIT-4	**INTRODUCTION TO MICROPROCESSORS** (CLASS ROOM TEACHING)	**08**
	Evolution of Microprocessor, Organization of Microprocessors (Preliminary concepts), basic concepts of programming of microprocessors. Review of concepts - Boolean algebra, Logic Gates and Gate Networks, Binary & Decimal number systems, memory representation of positive and negative integers, maximum and minimum integers. Conversion of real, numbers, floating point notation, representation of floating point numbers, accuracy and range in floating point representation, overflow and underflow, addition of floating point numbers, character representation. Central Processing Unit of Microprocessors**:** Introduction, timing and control unit basic concepts, Instruction and data flow, system timing, examples of INTEL 8085 and 4004 register organization.	
UNIT-5	**DATA WORD REPRESENTATION** (CLASS ROOM TEACHING)	**07**

	Data word representation. Basic elements of control systems 808SA processor architecture terminology such as CPU, memory and address, ALU, assembler data registers, Fetch cycle, write cycle, state, bus, interrupts. Micro Controllers. Difference between microprocessor and micro controllers. Requirements for control and their implementation in microcontrollers. Classification of micro controllers. Organization & Programming of Microprocessors**:** Introduction to organization of INTEL 808S-Data and Address buses, Instruction set & programming of 8085.	

TEXTBOOKS:

1. A Kuttan, "Introduction to Mechatronics, Oxford University Press, 2010.
2. Alciatore & Histand, "Introduction to Mechatronics & Measurement Systems, 4e", McGrawHill Education, 2014.
3. M Jouaneh, "Fundamentals of Mechatronics", Cengage Learning, 2013.
4. W. Bolton, "Mechatronics", Pearson Education, Second Edition, 1999.Bradley
5. D. A., Dawson D., Buru N.C. and. Loader A.J, "Mechatronics", Chapman and Hall, 1993

REFERENCE BOOKS:

1. Dan Necsulesu, "Mechatronics", Pearson Education Asia, 2002 (Indian Reprint).
2. NitaigourPremchandMahadik, "Mechatronics", McGraw-Hill Education, 2015.
3. Lawrence J. Kamm, "Understanding Electro – Mechanical Engineering, An Introduction to Mechatronics", Prentice – Hall of India Pvt., Ltd., 2000.
4. Ramachandran K. P., Vijayaraghavan G. K., Balasundaram M.S. "Mechatronics: Integrated Mechanical Electronic Systems", Wiley

CO1:
CO2:
CO3:
CO4:
CO5:

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	1	1	2	0	0	1	0	3
CO2	3	3	2	1	1	0	2	0	0	1	0	2
CO3	3	3	2	1	1	0	2	0	0	1	0	2
CO4	3	3	3	2	1	0	2	0	0	1	0	3
CO5	3	3	2	2	1	0	2	0	0	1	0	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2018-19 ACADEMIC YEAR: 2020-21
SEMESTER : FIFTH

COURSE TITLE : PRINCIPLES OF METAL FORMING (PROFESSIONAL ELECTIVE - 1)		
Sub Code: 18ME555	**No of Credits =03** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 100**
Pre-requisites	**Metallurgy, Strength of Materials, Manufacturing process**	

COURSE OBJECTIVES

1. Express and analyze the concept of different metal forming process, concepts of stress and Strain and its elastic relationships.
2. Express and analyze the concept of Plasticity, flow curve, yield criteria, plastic stress-strain relationship and effects of various parameters on flow properties.
3. Analyze and demonstrate hot and cold metal working, metallurgical consideration in metal working -forging and rolling process.
4. Analyze and demonstrate extrusion process.
5. Analyze and demonstrate sheet metal forming and powder metallurgy.

UNIT	**CONTENTS**	**Hrs.**
UNIT-1		**08**
	Introduction to metal Forming, classification of metal working process, behaviour of materials and its failure. Concept of stress-strain, description and state of stress in 3 dimension, description of strain, hydrostatic and deviator components of stress and strain. Elastic stress-strain relationships.	
UNIT-2		**08**
	Introduction to theory of plasticity and flow curve, true stress and true strain, yield criteria for ductile materials, plastic stress-strain relationships. Measure of yielding and ductility in tensile testing, instability in tension, strain rate and temperature effects on flow properties, influence of parameters on flow properties.	
UNIT-3		**08**
	Mechanics of metal working and analysis method, determination of flow stress in metal working, hot working and cold working, metallurgical consideration in metal forming. introduction and classification of forging process, forging in plane strain, Introduction and classification of rolling process, analysis of rolling load calculation	
UNIT-4	(**For Online class**)	**08**
	Introduction and classification of extrusion process, analysis of extrusion process, extrusion of tubes and pipes, introduction of rod and wire drawing, analysis of wire and tube drawing process.	
UNIT-5	Introduction and classification of sheet metal working operations and powder metallurgy forming.	**07**

Course Outcomes: At the end of the course, student will able to:

CO1: Ability to define Metal forming process and classification, concepts of stress-strain and its elastic relationships.
CO2: Concept of Plastic deformation in Metals and its flow characteristics with certain phenomenon.
CO3: The difference between Hot and cold forming, its associated metallurgical behavior and working principles of Forging and Rolling process.
CO4: Working principles of Extrusion, various classification of it. Wire drawing principle
CO5: Sheet Metal forming operations and its application and Powder metallurgy and its application

TEXT BOOKS:

1. Mechanical metallurgy (SI Units), G.E.Dieter, McGraw hill Pub-2001.
2. Ghosh A. Mallik A K Manufacturing science, Affiliated East-West press Pvt Ltd
3. Rowe, Geoffrey W. An Introduction to the principles of Metal working, TMH

REFERENCE BOOKS:

1. Materials & Process in Manufacturing – E.Paul, Degramo, J.T.Black, Ranold, A.K.Prentice-hall of India 2002
2. Fundamentals of Manufacturing Processes by Lal G K, Narosa
3. Textbook of Production Engineering by P. C. Sharma, S Chand & Company Ltd

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	3										
CO2	2	3										
CO3	2	3	3	3	3				1	1	1	1
CO4	2	3	3	3	3				1	1	1	1

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2018-19 ACADEMIC YEAR: 2020-21
SEMESTER : FIFTH

COURSE TITLE : EXPERIMENTAL STRESS ANALYSIS (PROFESSIONAL ELECTIVE – 1)		
Sub Code: 18ME556	**No of Credits : L-T-P-SS 3:0:0:0 =3**	**No. of lecture hours/week : 03 Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Mechanics of materials**	

COURSE OBJECTIVES:

1. Analyze stresses within the elastic range in 3D.
2. Compile strains and displacements.
3. Evaluate stress and strain relations for linear elastic materials.
4. Demonstrate the experimental methods for analyzing stresses and strains in given specimen.
5. Develop photo-elastic, Moire techniques and holography methods for analysing stresses experimentally.

. #	CONTENTS	Hrs.
UNIT-1	**PHOTOELASTICITY** (ONLINE TEACHING)	**07**
	Nature of light, Wave theory of light - optical interference, stress optic law – effect of stressed model in plane and circular polariscopes, Analysis of plane polariscope by Jones calculus, isoclinics & isochromatics, Fringe order determination, determination of fractional fringe order, photo-elastic model materials and Applications.	
UNIT-2	**TWO DIMENSIONAL PHOTOELASTICITY** (BLENDED TEACHING)	**08**
	Separation methods: Shear difference method, Analytical separation methods, Model to prototype scaling, Properties of 2D photo-elastic model materials, materials for 2D photo-elasticity.	
UNIT-3	**BRITTLE COATINGS** (BLENDED TEACHING)	**08**
	Coatings stresses, crack patterns, refrigeration techniques, load relaxation techniques, crack detection methods, types of brittle coatings, resin and ceramic based brittle coatings, calibration of coating, advantages and brittle coating applications.	
UNIT-4	**PHOTOELASTIC(BIREFRINGENT) COATINGS** (CLASSROOM TEACHING)	**08**
	Theory of birefringence coating stresses, sources of error, effects of coating thickness: reinforcing effects, poission's, stress separation techniques: oblique incidence, strip coatings.stress freezing technique, birefregent coating materials. **MOIRE METHODS:** Moire fringes produced by mechanical interference. Geometrical approach, out of plane displacement measurements, applications and advantages.	
UNIT-5	**ELECTRICAL RESISTANCE STRAIN GAUGES** (CLASSROOM TEACHING)	**08**
	Gauged factors & strain sensitivity in metallic alloys, gauge construction, characteristics of strain gauges, adhesives and mounting techniques, gauge sensitivity and gauge factor, performance characteristics, environmental effects, strain gauge circuits. wheatstone's potentiometer bridges, constant current strain gauge circuits. **STRAIN ANALYSIS METHODS:** Two element, three element rectangular and delta rosettes, stress-strain relations, correction for transverse strain effects.	

TEXT BOOKS:

1. “Experimental Stress Analysis”, Dally and Riley, McGraw Hill.
2. “Experimental Stress Analysis”. Sadhu Singh, Khanna publisher.

3. Experimental stress Analysis, Srinath L.S tataMcGraw Hill.

REFERENCES BOOKS:

1. “PhotoelasticityVol I and VolII,M.M.Frocht, John Wiley & sons.
2. “Strain Gauge Primer”, Perry and Lissner,
3. “Photo Elastic Stress Analysis”, Kuske, Albrecht & Robertson John Wiley &Sons.
4. “Motion Measurement and Stress Analysis”, Dave and Adams.

COURSE OUTCOMES: On completion of the course, students will be able to
CO1: Analyze stresses within the elastic range of materials.
CO2: Compile strains and displacements.
CO3: Evaluate stress and strain relations for linear elastic materials.
CO4: Describe the importance of experimental methods in analyzing stress and strain.
CO5: Describe photo elastic, Moiré technique of experimental stress analysis Validate results with experiments.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	2	1	1	1	1	2	1	1
CO2	3	3	2	3	1	1	1	2	1	1	1	2
CO3	3	3	3	2	2	1	1	1	2	1	1	1
CO4	3	3	3	1	2	1	1	1	1	2	1	2
CO5	3	3	2	2	1	1	1	1	2	1	1	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2018-19 ACADEMIC YEAR: 2020-21
SEMESTER : FIFTH

COURSE TITLE : COMPUTER AIDED MANUFACTURING LABORATORY		
Sub Code: 18MEL56	**No of Credits =01** **L-T-P-SS::0:0:2:0**	**No. of practical hours/week : 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 50**
Pre-requisites	**CAD/CAM**	

COURSE OBJECTIVES:

1. Computer based numerically controlled machine tools are increasingly finding place in industries.
2. Further integration of the computer Aided Design Drafting (CADD), which has been in use in the industry for some years now, with (CAM) Operations has led to efficient product design & prototyping and shorter production runs.
3. The need to absorb, CAD/ CAM technology for its effectives has, therefore, become imperative.
4. This course is being introduced as Practical course of BE programme in mechanical engineering.
5. The course aims at developing appreciation of the use of CAD/CAM environment, its Components, their functions, and methods of using the existing CAD/ CAM software, in general, with a view to improve efficiency in drafting and designing.

SL No.	**CONTENTS**	**Hrs**
PART A	➢ Three typical simulations to be carried out using simulation packages like Master-CAM, or any equivalent software. ➢ Simulation of Turning, Drilling, Milling operations.	**10**
PART B	➢ Executing NC part programming using software package like Spectra light or any equivalent software ➢ NC programming on milling operations, turning operations and drilling operations has to be written and executed.	**10**
PART C	**(ONLY FOR DEMO/VIVA VOCE)**	**06**
	➢ Pneumatics and Hydraulics, Electro-Pneumatics: Three typical experiments on Basics of these topics to be conducted. ➢ FMS (Flexible Manufacturing System): Programming of Automatic storage and Retrieval system (ASRS) and linear shuttle conveyor Interfacing CNC lathe, milling with loading unloading arm and ASRS to be carried out on simple components. ➢ Robot programming: Using Teach Pendent & Offline programming to perform pick and place, stacking of objects, 2 programs.	

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Gain the knowledge on CNC programming using CAM packages.

CO2: Learn and perform the programming and simulation robots.

CO3: Learn and understand the programming of automatic storage, retrieval system and linear shuttle conveyor system through demo.

CO4: Understand the function and handling of hydraulic, pneumatic and electro-pneumatic systems through demo.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	2	3	3	1	1	1	1	3	1
CO2	3	3	2	1	3	2	1	1	1	1	3	1
CO3	3	3	2	2	2	2	1	1	2	1	3	1
CO4	3	3	2	2	2	2	1	1	2	1	3	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

SCHEME OF EXAMINATION	
Two questions from Unit 1(Milling and turning)	40 Marks (10 Write up +30)
Viva Voce	10 Marks
Total	**50 Marks**

ADMISSION YEAR : 2018-19 ACADEMIC YEAR: 2020-21
SEMESTER : FIFTH

COURSE TITLE : FUEL TESTING AND INTERNAL COMBUSTION ENGINES LABORATORY		
Sub Code: 18MEL57	**No of Credits : L-T-P-SS 0:0:2:0 = 1**	**No. of practical hours/week: 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 50**
Pre-requisites	**Basic Thermodynamics, Applied Thermodynamics**	

COURSE OBJECTIVES

1. To conduct tests on oils to determine flash, fire points and viscosity.
2. To determine calorific value of a given fuel.
3. To plot the valve timing diagram of 2-stroke and 4-stroke IC engine.
4. To calculate the area of an irregular shape using planimenter.
5. To conduct performance test on petrol and diesel IC engine and evaluate the power produced and efficiencies; to conduct Morse test on 4-stroke multi cylinder engine to determine the utility heat input and draw heat balance sheet.

UNIT	**CONTENT**	**Hrs**
1.	**<u>MINOR EXPERIMENTS</u>** (i) Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Martin (closed) **(or)** Cleave land (Open Cup) Apparatus. (ii) Determination of Calorific value of solid, liquid and gaseous fuels. (iii) Determination of Viscosity of lubricating oil using Redwoods Saybolts and Torsion Viscometers. (iv) Valve Timing of a four stroke I.C. engine. **(or)** port opening diagram of an 2 stroke I.C. engine. (v) Use of planimeter	**10**
2.	**<u>MAJOR EXPERIMENTS</u>** Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal efficiencies, SFC, FP, heat balance sheet for (i) Four stroke Diesel Engine (ii) Four stroke Petrol Engine (iii) Two stroke Petrol Engine (iv) Morse test to evaluate the friction power in Multi Cylinder Diesel/Petrol Engine	**16**

REFERENCE BOOKS

1. Basic and Applied Thermodynamics, P.K. Nag, Tata McGraw-Hill Publications, 2nd Edition, 2010.
2. Internal Combustion Engines, V Ganeshan, Tata McGraw-Hill Publications, 4th Edition, 2012.

COURSE OUTCOMES: On completion of the course, student should be able to
CO1: Understand the importance of lubricating oil properties such as fire, flash, cloud, pour points and viscosity to know their operating conditions.
CO2: Analyse and compare the calorific values of various types of fuels.
CO3: Determine area of irregular shapes using Planimeter.
CO4: Plot valve timing diagram and then to conduct performance tests on different types of IC engines. Also to determine various parameters including heat balance sheet.

MAPPING OF COs WITH Pos												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	1	3	0	1	2	1	2	1	3	3
CO2	3	3	1	3	0	1	2	1	2	1	3	3
CO3	3	3	1	3	0	1	2	1	3	2	3	3
CO4	3	3	1	3	0	1	2	1	3	2	3	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

Sl. No.	**Particulars**	**Max Marks**	**Break up Max. Marks**		
			Write up	**Conduction of experiment**	**Calculations, Results and graphs**
1	**MINOR EXPERIMENTS** Any one from list of experiments	15	5	5	5
2	**MAJOR EXPERIMENTS** Any one from list of experiments	25	5	10	10
3	**Viva Voice**	10	-	-	-
		50	10	15	15

ADMISSION YEAR : 2018-19 **ACADEMIC YEAR: 2020-21**
SEMESTER : SIXTH

COURSE TITLE : DESIGN OF MACHINE ELEMENTS – II		
Sub Code: 18ME61	**No of Credits =04** **L-T-P-SS:: 3:2:0:0**	**No. of lecture hours/week: 04** **Total Number of Lecture hours : 65**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**MOM, KOM, Design of Machine Elements-I**	

COURSE OBJECTIVES:

1. The student shall gain appreciation and understanding straight and curved beams and general applications of curved beams such as machine frame, punching machine and crane hook, bending and resultant stress occurs at various symmetrical and non-symmetrical crass sections and extended chain links used for curved beams. Student shall be able to understand the concept of thick cylinders and calculate the pressure developed in thick cylinder using lame's equation.
2. The student shall be able to understand functions of various spring and its application, types of springs, such as helical, spiral, buffer, concentric and leaf springs and stress induced, deflection, energy stored in the spring, design procedure, selection of suitable material to design and design springs for various suitable applications.
3. The student shall be able to understand meaning of gear drive importance of gear drive, various fields of applications, general classifications, general characteristics, requirements of gear drive, types of tooth profile, loads, selection of suitable material for gear design stress acting on gears and design procedure to design a different gear for various applications.
4. The student shall be able to understand functions of lubrications, desirable properties, types of lubrications system, selection proper grade of lubrication for particular application and also to understand functions of bearing, general classification, design procedure to design any bearing, selection of various factors for bearings, determination of life of bearing, selection of proper grade of lubrication suitable and heat generated, heat dissipated etc.

UNIT	**CONTENTS**	**Hrs**
UNIT-1	**CURVED BEAMS** and **THICK CYLINDERS** (CLASS ROOM TEACHING)	**9L+4T**
	CURVED BEAMS: Assumptions made in the analysis of curved beams, stress equation, difference between straight and curved beam, Design of curved beams: Bending stresses and resultant normal stress in curved beams of standard cross sections used in crane hook, punching presses & clamps, closed rings and links. Numericals **THICK CYLINDERS**: Design of thick cylinders subjected to an internal pressure using Lame's equation. Numericals	
UNIT-2	**SPRINGS** (BLENDED TEACHING)	**9L+4T**
	SPRINGS: Introduction, classification of springs, stresses in helical coil springs of circular sections, deflection equation, energy stored in springs and problems on helical coil springs, buffer springs, concentric springs- advantages, applications and design of concentric springs, springs under fluctuating loads. Leaf Springs, advantages and applications, nipping, stresses in leaf springs, semi elliptical leaf spring. Numericals	
UNIT-3	**POWER TRANSMISSION** (CLASS ROOM TEACHING)	**9L+4T**

	SPUR GEAR DRIVES: Introduction, classification, advantage, dis-advantages and applications, terminology of spur gears, material selection for spur gear design, stresses in gear tooth, Lewis equation and form factor, calculation of centre distance, module and face width, Check for dynamic and wear load considerations and numerical problems on spur gear. **HELICAL GEARS:** Introduction, classification, advantage, dis-advantages and applications, terminology of helical gears, formative number of teeth, material selection for helical gear design, stresses in gear tooth, Lewis equation and form factor, Estimation of centre distance, module and face width, Check for dynamic and wear load considerations and numerical problems on spur gear.	
UNIT-4	**BEVEL GEARS and WORM GEARS** (CLASS ROOM TEACHING)	**9L+4T**
	BEVEL GEARS: Introduction, classification, advantage, applications, terminology of bevel gears, formative number of teeth, material selection for bevel gear design, stresses in gear tooth: Lewis equation and form factor, design for strength, dynamic load and wear load, problems on bevel gear. **WORM GEARS**: Introduction, classification, advantage, applications, terminology of worm gears, material selection for worm gear design, stresses in gear tooth: Lewis equation, Design for strength, Dynamic load and wear loads and efficiency of worm gear drives and Numerical problems on worm gears.	
UNIT-5	**LUBRICATION and BEARINGS** (ONLINE TEACHING)	**9L+4T**
	LUBRICATION: Introduction to Lubrication and their properties, types of lubrication, Mechanisms of Lubrication, bearing modulus, coefficient of friction, minimum oil film thickness, Heat generated, Heat dissipated. Types and selection of Mechanical Seals. **BEARINGS:** Classification, Bearing Materials, types of bearing and designation, Selection of rolling contact bearings based on constant / variable load & speed conditions (includes deep groove ball bearing, cylindrical roller, spherical roller, taper roller, self-aligning bearing and thrust bearing). Design of ball bearing and journal bearing. Thrust bearings. Numerical problems.	

TEXT BOOKS

1. **Mechanical Engineering Design**, Joseph E Shigley and Charles R. Mischke. McGraw Hill International edition, 6th Edition 2003.
2. **Design of Machine Elements**, V. B Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2007.

REFERENCE BOOKS

1. Machine Design, Robert L. Norton, Pearson Education Asia, 2001.
2. Design of Machine Elements, M. F. Spotts, T. E. Shoup, L. E. Hornberger, S. R. Jayram and C. V. Venkatesh, Pearson Education, 2006.
3. Machine Design, Hall, Holowenko, Laughlin (Schaum's Outlines series) Adapted by S.K. Somani, Tata McGraw Hill Publishing Company Ltd., New Delhi, Special Indian Edition, 2008.

4. Machine Design, A CAD Approach: Andrew D DIMAROGONAS, John Wiley Sons, Inc, 2001.

DESIGN DATA HANDBOOK

1. **Design Data Hand Book**, K. Lingaiah, McGraw Hill, 2nd Edition.
2. **Data Hand Book,** K. Mahadevan and Balaveera Reddy, CBS Publication
3. **Design Data Hand Book,** H.G. Patil, ShriShashi Prakashan, Belgaum.

COURSE OUTCOMES: After completion of the course, students will be able to:

CO1: Design and evaluate a mechanical system (straight and curved beams with symmetric and non-symmetric sections for various engineering applications)/process which is environment friendly with appropriate consideration for public health and safety

CO2: Analyze & design helical compression & tension springs with respect to static & dynamic axial loads

CO3: Design gears based on the given conditions and select appropriate gears for power transmission on the basis of given load and speed experienced to design spur and helical gears with respect to tooth bending strength.

CO4: Design gears based on the given conditions and select appropriate gears for power transmission on the basis of given load and speed experienced to design bevel, & worm gears with respect to tooth bending strength

CO5: Compute equivalent radial loads for rolling contact bearing & select appropriate bearing for industrial applications using manufacturer's catalogue data.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	2	2	3	2	3	1	3	3
CO2	2	3	3	2	3	3	3	1	2	3	3	2
CO3	3	3	2	3	3	3	3	1	3	2	3	2
CO4	3	3	2	3	3	2	3	2	1	2	3	3
CO5	3	3	3	3	2	2	3	2	3	1	3	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										
3.Design Data Hand Book is permitted										

ADMISSION YEAR : 2018-19 ACADEMIC YEAR: 2020-21
SEMESTER : SIXTH

COURSE TITLE : HEAT TRANSFER		
Sub Code: 18ME62	**No of Credits : L-T-P-SS 3:2:0:0 =4**	**No. of lecture hours/week : 04 Total Number of Lecture hours : 65**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Basic thermodynamics, Fluid mechanics**	

COURSE OBJECTIVES:
1. To outline the basic concepts of conduction, convection and radiation heat transfer. 2. To discuss and illustrate the application of various boundary conditions giving heat transfer examples.
3. To understand the unsteady heat conduction and convection heat transfer and apply the knowledge to solve real time problems.
4. To demonstrate the use of graphical charts for solving analytical problems.
5. To design heat exchangers based on the input variables such as inlet temperature of hot and cold fluids.
6. To evaluate various heat transfer parameters and predict the rate of heat transfer and heat transfer coefficients.

#	CONTENTS	Hrs.
UNIT-1	**BASIC CONCEPTS AND CONDUCTION HEAT TRANSFER** (BLENDED MODE)	**9L+4T**
	Introduction - Modes of heat transfer, Basic laws, Combined heat transfer mechanism, Resistance concept, Boundary conditions of 1st, 2nd and 3rd kind; Thermal contact resistance; Overall heat transfer coefficient; Illustrations of applying the boundary conditions to heat transfer problems; Derivation of general equation of heat conduction in Cartesian coordinates; Special cases; Discussion on 3-D conduction in cylindrical and spherical coordinate systems (No derivation);Steady state heat conduction in simple and composite slabs, cylinders and spheres (uniform thermal conductivity and without heat generation); Related numerical problems; Introduction to variable thermal conductivity and heat generation; Concept and derivation of critical thickness of insulation in cylinders and spheres (No numerical problems on variable thermal conductivity, heat generation and critical thickness)	
UNIT-2	**EXTENDED SURFACES AND UNSTEADY STATE HEAT CONDUCTION TRANSFER** (CLASSROOM MODE)	**9L+4T**
	Introduction to extended surfaces; Derivation of heat transfer and temperature distribution in fins (uniform cross-section without heat generation); Long fin, short fin with insulated tip and without insulated tip and fin connected between two heat sources; Fin efficiency and effectiveness; Related numerical problems. Unsteady state heat conduction - Introduction; Conduction in solids with negligible internal temperature gradient (Lumped system analysis), Use of Transient temperature charts (Heisler's charts) for transient conduction in slab, long cylinder and sphere; Use of transient temperature charts for transient conduction in semi-infinite solids; Related numerical problems.	
UNIT-3	**CONVECTION HEAT TRANSFER** (CLASSROOM MODE)	**9L+4T**
	Introduction – Boundary layer concept in external and internal flow; Forced Convection - Dimensional analysis for forced convection; Physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers; Use of correlations for flow over simple geometries (flat plate, cylinder and sphere); Use of correlations for flow inside a duct; Numerical problems; Free	

	or natural convection - Dimensional analysis for free convection; Physical significance of Grashof number; Use of correlations of free convection over flat plates (vertical, horizontal and inclined), cylinders (vertical and horizontal) and spheres; Related numerical problems; Introduction to boiling: pool boiling, Bubble Growth Mechanisms, Nucleate Pool Boiling, Critical Heat Flux in Nucleate Pool Boiling, Pool Film Boiling, Critical Heat Flux, Heat Transfer beyond the Critical Point, filmwise and dropwise Condensation (No numerical problems on boiling and condensation)	
UNIT-4	**HEAT EXCHANGERS** (CLASSROOM MODE)	**9L+4T**
	Introduction; Classification of heat exchangers; Compact, Shell-and-tube and Plate heat exchangers; Overall heat transfer coefficient and fouling factor; Parallel and counter flow heat exchangers; Use of LMTD; Cross flow heat exchangers; Comparison of parallel and counter flow heat exchangers; Heat transfer with phase change; Multi pass heat exchangers; Effectiveness-NTU method; Limiting cases; Related numerical problems; Compact heat exchangers – Introduction, types, advantages; Heat pipes – Introduction; Working principle; components; Applications; Limitations	
UNIT-5	**RADIATION HEAT TRANSFER** (ONLINE MODE)	**9L+4T**
	Introduction; Fundamental principles - Gray, White, Opaque, Transparent and Black bodies, Spectral emissive power, Wien's displacement law, Planck's laws, Hemispherical Emissive Power, Stefan-Boltzmann law for the total emissive power of a black body, Emissivity and Kirchhoff's Laws; Black bodies separted by a non-absorbing medium; Shape factor; Electrical analogy; Two black surfaces connected by non-conducting and re-radiating walls; Evaluation of shape factor; Radiation heat transfer between gray bodies; Radiosity and Irradiation; Radiation network for gray surfaces exchanging energy; Hottel's crossed string method; Radiation shields; Related numerical problems	

TEXT BOOKS

1. **Heat and Mass Transfer,** P.K. Nag, 3rd Edition, Tata McGraw-Hill Publications, 2011.
2. **A Course in Heat and Mass Transfer,** Domkundwar, Arora, Domkundwar, Dhanpat Rai Publications, 2005.

REFERENCE BOOKS

1. **Heat and Mass Transfer: Fundamentals and Applications**, Cengel,Y.A., and Ghajar, A.J., 5th Edition, McGraw-Hill Publications (SIE), 2015.
2. **Principles of Heat and Mass Transfer**, Frank P. Incropera, David P. Dewitt, Theodore L. Bergman, and Adrienne S. Lavine, 7th Edition, Wiley Student Edition, 2013.

e-LEARNING RESOURCES

1. **A Heat Transfer Text Book**, John H Leinard IV and John H Leinard V, 3rd Edition, Phlogiston Press, Cambridge, Massachusetts, USA, 2008.
2. **Heat and Mass Transfer: Mechanical Engineering Handbook**, Kreith, F., Boehm, R.F., et. al., Frank Kreith (Ed), Boca Raton: CRC Press LLC, 1999.
3. **Fundamentals of Heat and Mass Transfer**, Frank P. Incropera, David P. Dewitt, et. al. Frank P. Incropera (Ed), 6th Edition, John Wiley and Sons, 2007.
4. **e-Journal: Frontiers in Heat and Mass Transfer**, http://www.ThermalFluidsCentral.org
5. **Videos, Student slides, Handouts, Lecture notes:** http://www.nptel.ac.in

DATA HAND BOOK AND CHARTS

1. **Heat and Mass Transfer Data Hand Book,** C.P. Kothandaraman, S. Subramanyan, New Age International Publishers, 8th Edition, 2014.
2. **Steam Tables with Mollier Diagram: SI Units**, Mahesh M.Rathore, Dhanpat Rai Publishing Company, 2014.

COURSE OUTCOMES: On completion of the course, students will be able to:

CO1: *Understand* the basic modes of heat transfer applied to simple and composite solids; *understand* the numerical analysis of one dimensional steady state heat transfer.
(RBTL: 1, 2, 3)

CO2: *Understand* the application of extended surfaces in heat conduction and *analyse* the unsteady conduction heat transfer in infinite and semi-infinite bodies; *use* transient charts to *solve* to problems of different complexity; *understand* the numerical analysis of one dimensional steady state heat transfer. (RBTL: 1, 2, 3)

CO3: *Interpret* and *analyse* forced and free convection heat transfer; *Understand* the phenomenon of boiling and condensation and *use* correlations to solve numerical problems. (RBTL: 1, 2, 3)

CO4: *Analyse* temperature distribution in heat exchangers; *develop* expressions and *design* the heat exchanger for the maximum effectiveness; *solve* numerical problems.
(RBTL: 1, 2, 3)

CO5: *Understand* the principles thermal radiation heat transfer; *develop* expressions for net radiation between various types of bodies; *solve* numerical problems. (RBTL: 1, 2, 3)

(RBTL: Revised Bloom's Taxonomy Levels; 1 – Remembering, 2 – Understanding, 3 – Applying, 4 - Analyzing, 5 - Evaluating, 6 - Creating)

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										
3. Each full question shall have maximum of 3 sub-divisions										

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	0	0	0	2	1	1	1	0	1
CO2	3	3	3	0	0	0	2	1	1	1	0	1
CO3	3	3	3	0	0	0	2	1	1	1	0	1
CO4	3	3	3	0	0	0	2	1	1	1	0	1
CO5	3	3	3	0	0	0	2	1	1	1	0	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

ADMISSION YEAR	**:**	**2018-19**	**ACADEMIC YEAR: 2020-21**
SEMESTER	**:**	**SIXTH**	

COURSE TITLE : MECHANICAL VIBRATIONS		
Sub Code: 18ME63	**No of Credits =03** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 3**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Engineering physics, DOM**	

COURSE OBJECTIVES:

1.To study basic concepts of vibration analysis and observe, analyze, understand the concept of vibrations in mechanical systems , various technique to solve single degree freedom and single DOF without damping with damping, 2-degree, forced vibration and, Estimate natural frequency of mechanical system multi degree freedom system using various numerical techniques.

2. To acquaint with the principles of vibration measuring instruments

3. To recognize how to apply theory of vibration to engineering problems.

4. To study balancing of mechanical systems, and able to mathematically formulate real-world vibration problems in engineering.

#	CONTENTS	Hrs
UNIT-1	**BASIC CONCEPTS OF VIBRATION** (ONLINE TEACHING) Vibration and oscillation, causes and effects of vibrations, Vibration parameters – spring, mass, damper, Damper models, Motion – periodic, non-periodic, harmonic, non- harmonic, Degree of freedom, static equilibrium position, Vibration classification, Steps involved in vibration analysis. Definitions, Simple Harmonic Motion (S.H.M.), Work done by harmonic force, Beats. **FREE UNDAMPED SINGLE DEGREE OF FREEDOM VIBRATION SYSTEMS** (CLASSROOM TEACHING) Longitudinal, transverse, torsional vibration system, Methods for formulation of differential equations by Newton, Energy and Rayleigh's Method, Different methods of determination of natural frequencies of simple systems, Springs in series and parallel, Torsional and transverse vibrations, Effect of mass of spring and problems.	**08**
UNIT-2	**FREE DAMPED SINGLE DEGREE OF FREEDOM VIBRATION SYSTEMS:** (CLASSROOM TEACHING) Types of damping**,** Analysis with viscous damping - Derivations for over damped, critically damped and under damped systems, Logarithmic decrement and numericals. **Rotor Dynamics:** Critical speed of single rotor, undamped and damped vibrations and numericals.	**07**
UNIT-3	**FORCED VIBRATIONS** (CLASSROOM TEACHING) Introduction**,** Analysis of forced vibration with constant harmonic excitation - magnification factor, rotating and reciprocating unbalances, support excitation for relative and absolute amplitudes, force and motion transmissibility and numericals. **Vibration Measurement**: (BLENDED TEACHING) Principle of seismic instruments, vibrometer, and accelerometer - undamped, damped, Frequency measuring instruments.	**08**

UNIT-4	**SYSTEMS WITH TWO DEGREES OF FREEDOM** (CLASSROOM TEACHING) Principle modes and normal modes of vibrations, natural frequencies of systems (without damping) – Simple spring mass systems, torsional systems, combined rectilinear and angular systems, geared semi-defined systems, semi-definite systems, Dynamic vibration absorber and numericals.	**08**
UNIT-5	**NUMERICAL METHODS FOR MULTI DEGREE FREEDOM OF SYSTEMS**: (CLASSROOM TEACHING) **(i)(A) Free Undamped Multi Degree Freedom System:** Introduction, Maxwell's reciprocal theorem, Influence coefficients, and numerical. **(B) Multi Degree System Numerical Methods:-** (i) Rayleigh`s, (ii) Dunkerley's (iii) Stodola (iv) Holzer`s Numericals	**8**

TEXT BOOKS:

1. **Mechanical Vibrations,** G. K.Grover, Nem Chand and Bros, 7th edition, 2003.
2. **Mechanical Vibrations,** S. S. Rao, Pearson Education Inc, 4th edition, 2003.
3. **Mechanical Vibrations,** V. P. Singh, DhanpatRai& Company, 3rd edition, 2006.

REFERENCE BOOKS:

1. **Theory of Vibration with Applications,** W. T. Thomson, M. D. Dahleh and C. Padmanabhan, Pearson Education Inc, 5th edition, 2008.
2. **Mechanical Vibrations:** S. Graham Kelly, Schaum's outline Series, Tata McGraw Hill, Special Indian Edition, 2007.
3. **Theory and Practice of Mechanical Vibrations:** J. S. Rao& K. Gupta, New Age International Publications, New Delhi, 2001.
4. **Vibration Fundamentals**, R. Keith Mobley, Newness, 1999.

COURSE OUTCOMES: After completion of the course, students will be able to:
Understand the different method to determine the fundamental natural frequencies of SDOF without damping.
CO2: Solve the different parameters of single degree damped vibrations by the basic knowledge of damped vibration and also rotor dynamics.
CO3: Ability to find vibration parameters numerically for forced vibration and also explore modern vibration measuring instruments, condition monitoring of working machineries.
CO4: Determine fundamental natural frequencies of two degree freedom systems without damping, semi definite systems.
CO5: Find influence coefficient of spring mass system and apply the numerical methods to find the frequency of multi degree freedom system

MAPPING OF COs WITH Pos												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	2	2	1	1	0	0	0	0	2
CO2	3	3	3	2	2	1	2	0	0	0	1	2
CO3	3	3	3	2	2	2	2	0	1	0	1	3
CO4	3	3	3	2	2	2	2	0	1	0	2	3
CO5	3	3	3	3	3	2	2	0	1	0	2	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2018-19 ACADEMIC YEAR: 2020-21
SEMESTER : SIXTH

COURSE TITLE : INSPECTION AND QUALITY CONTROL (PROFESSIONAL ELECTIVE – 2)		
Sub Code: 18ME641	**No of Credits =03** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Engineering Mathematics**	

COURSE OBJECTIVES:

1. The student should learn different inspection procedures, objectives in industry and economic aspects.
2. To impart definition of quality, components, concepts and different approaches followed like quality circles, cost of quality and economic considerations in quality.
3. To impart knowledge on various quality standards followed.
4. To impart fundamentals of statistical quality control charts, and process capability.
5. To impart different sampling techniques and reliability.

#	CONTENTS	Hrs.
UNIT-1	**INDUSTRIAL INSPECTION and CONCEPT OF QUALITY IN ENGINEERING** (BLENDED TEACHING)	08
	Industrial inspection: Objectives and functions of inspection in industry, types of inspection, production / inspection interaction, organization for industrial inspection, inspection procedures, economic aspect of inspection. **Concept of Quality in Engineering:** Meaning and significance of quality; essential components of quality; phases or elements for building quality; evolution of the concepts of quality; spiral of progress of quality; quality cost, hidden quality costs; economic models of quality costs, changing scope of quality activities.	
UNIT-2	**QUALITY MANAGEMENT SYSTEMS , QUALITY CONTROL FUNCTION and ASPECTS OF SPECIFICATION AND TOLERANCES** (BLENDED TEACHING)	08
	Quality Control Function: Inspection versus quality control techniques, quality planning activities, organization for quality control. Fundamentals of statistical quality control, Juran's quality trilogy. **Aspects Of Specification And Tolerances:** Aspects of Specification and Tolerances: purpose of specification and tolerances, effect of careless setting of specification limits, setting realistic tolerances, statistical tolerancing, statistical theorem, Precision. Reproducibility and Accuracy, Simple numerical problems.	
UNIT-3	**CONTROL CHARTS** (CLASSROOM TEACHING)	07
	Control Charts: Basics of Control Chart: Variability, Kinds of variations, Types of errors, Control limits specification limits and Natural Tolerance limits, Charts for variables and attributes, application of control charts for averages, range, standard deviation, Interpretation of X-bar and R Charts- cyclic patterns, mixture, shift, trend and stratification, fraction defectives (p Chart) and number of non-conformities per unit (c Chart), process capability analysis and simple numerical problems.	
UNIT-4	**ACCEPTANCE SAMPLING & RELIABILITY** (CLASSROOM TEACHING)	08
	Acceptance Sampling: Elementary concepts, sampling by attributes, single, double and multiple sampling plans, construction and use of operating characteristic curves and simple problems.	

	Reliability: Reliability engineering, rectification processes in industries, practical activity – quality report building, reliability function, failure rate, mean time between failures (MTBF), mean time to failure (MTTF), mortality curve, useful life availability, maintainability, system effectiveness and simple numerical problems on reliability, MTBF and MTTF.	
UNIT-5	**QUALITY TOOLS AND SYSTEMS & TOTAL QUALITY MANAGEMENT** (BLENDED TEACHING)	**08**
	Quality Management Systems: Introduction to various quality standards - ISO 9000, BIS. **Quality Tools:** Ishikawa's seven quality tools; Quality Circles; Quality system economics, **Total Quality Management (TQM)** – definition, objectives, philosophy, and total productive maintenance (TPM) – definition, objectives, principles, implementation of TPM. Difference between TQM and TPM.	

TEXT BOOKS

1. Juran, J. M. and Gryna, F. M., Quality Planning & Analysis, Tata McGraw Hill, New Delhi (1995).
2. Grant, E. L., Statistical Quality Control, McGraw Hill International, New York (2005).
3. Charles E Ebling, An introduction to reliability and maintainability engineering, Tata McGraw-Hill Education, 2004 – Maintainability (Engineering).

REFERENCE BOOKS

1. Feignbaum, A. V., Total Quality Control, McGraw Hill International, New York (1991).
2. Besterfield, D.H., Total Quality Management, Pearson Education Asia, New Delhi (2003)

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Gain a knowledge on industrial inspection activity and concept of quality in engineering.

CO2: Understand various quality systems, quality control function, specification and tolerances prevalent in industry.

CO3: Construct various control charts based on data available in an industrial production, can also dwell upon the status of a process whether in control or out of control and find number of defectives.

CO4: Carry out sampling, reliability techniques with an industrial application.

CO5: Learn about applying different quality tools and total quality management.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	3	1	0	0	2	1	2	2
CO2	3	3	2	1	3	1	0	0	1	1	2	1
CO3	3	3	2	1	3	1	0	0	2	1	2	2
CO4	3	2	3	1	3	1	0	0	2	1	2	2
CO5	3	3	2	1	3	1	0	0	2	1	2	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2018-19 ACADEMIC YEAR: 2020-21
SEMESTER : SIXTH

COURSE TITLE : ADVANCED WELDING TECHNOLOGY (PROFESSIONAL ELECTIVE – 2)		
Sub Code: 18ME642	**No of Credits =03** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks : 50**	**Exam Marks : 100**
Pre-requisites	**Manufacturing process**	

COURSE OBJECTIVES

1. To understand the working principle, advantages, disadvantages of arc, gas and thermit welding.
2. The student gains information on different solid-state welding processes.
3. To understand the working principle, weld characteristics and process parameters of power beam welding.
4. To understand the process of thermal cutting of materials, brazing and soldering.
5. To understand the concept about underwater welding, welding in space and welding metallurgy.

#	CONTENTS	Hrs.
UNIT 1	**ARC, GAS AND THERMIT WELDING PROCESSES** (CLASSROOM TEACHING)	**08**
	Classification of welding processes, energy sources used in welding, working principle, process variables, advantages, limitations and applications of electro slag and electro gas welding, resistance welding, gas welding, plasma arc welding and thermit welding.	
UNIT 2	**SOLID STATE WELDING PROCESSES**(CLASSROOM TEACHING)	**08**
	Working principle, process variables, advantages, limitations and applications of Friction welding friction stir welding, ultrasonic welding, diffusion welding and explosion welding	
UNIT 3	**POWER BEAM WELDING PROCESSES** (CLASSROOM TEACHING)	**07**
	Working principle, process variables, advantages, limitations and applications of Electron beam and Laser beam welding	
UNIT 4	**BRAZING, SOLDERING AND THERMAL CUTTING** (ONLINE TEACHING)	**08**
	Introduction, brazing, soldering, various techniques, their advantages, limitations and applications; brazing & soldering consumables. Oxy- Acetylene cutting- working principle, metal powder cutting, introduction to oxygen/air / plasma / metal arc cutting arc cutting and gouging; advantages, limitations and applications of various techniques	
UNIT 5	**UNDERWATER WELDING, WELDING IN SPACE AND WELDING METALLURGY**(BLENDED TEACHING)	**08**
	Introduction to wet and dry under water welding & cutting Introduction, welding techniques, difficulties and advantages of welding in space. Welding metallurgy: Introduction, thermal cycles, prediction of peak temperature, pre heat and cooling rate, weldability of carbon steel, stainless steel & aluminum. Hot & cold cracking phenomenon, weld defects, causes and their remedies. Welding of Cu, Al, Ti and Ni alloys – processes, difficulties, microstructures, defects and remedial measures	

TEXT BOOKS:

1. S.V.Nadkarni, "Modern Arc Welding Technology", Oxford & IBH.
2. R.Little, "Welding Technology, TMH. WELDING CODES AND STANDARDS ME-9111 L T P.
3. Welding metallurgy by Sindo Kou, Welding metallurgy, 2nd Edition Nov. 2002, Wiley

REFERENCE BOOKS:

1. H.B.Cary, "Modern Arc Welding Technology", Englewood Cliffs, Prentice Hall.
2. Leonard P Connor, Welding Hand book, Volume I-III, AWS.
3. Metals Hand book, Volume 6, American Society of Metals.
4. Dave Smith, "Welding skills and technology", McGraw Hill.
5. Parmer R. S., 'Welding processes and Technology", Khanna Publishers, 1997
6. Robert W Messler, Jr. " Principles of welding, Processes, physics, chemistry and metallurgy", Wiley,2004.
7. Larry Jeffus, " Welding Principles and Applications" Fifth edition, Thomson,2002
8. Christopher Davis, 'Laser Welding - A Practical Guide', Jaico Publishing House, 1994.
9. Mishra. R.S and Mahoney. M.W, Friction Stir Welding and Processing, ASM,2007

COURSE OUTCOMES: On completion of the course, student should be able to;
CO1: Understand the mechanism, working principle and process characteristics of different arc, gas and thermit welding processes.
CO2: Have in depth knowledge on working principle, process characteristics of friction, friction stir, ultrasonic, explosion welding and diffusion bonding.
CO3: Describe the mechanism, working principle and process characteristics of high energy beam welding.
CO4: Differentiate between soldering and brazing, their techniques, advantages and limitations, applications and also decide on best cutting techniques for a specific application and their limitations.
CO5: Describe working principle and process characteristics of underwater welding processes, welding in space. And also Welding and weldability of different metals, hot& cold cracking phenomenon, weld defects and their causes and remedies

MAPPING OF COs WITH POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	1	2	0	1	1	1	1	1	0
CO2	2	3	2	1	2	0	0	1	1	2	1	1
CO3	3	3	2	1	2	0	1	1	1	2	1	1
CO4	2	3	3	1	2	0	0	1	1	2	0	1
CO5	3	2	3	1	2	0	1	1	0	1	1	0

Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	

1. Two full questions (each of 20 Marks) are to be set from each unit.

2. Student shall answer five full questions selecting one full question from each unit.

ADMISSION YEAR : 2018-19 ACADEMIC YEAR: 2020-21
SEMESTER : SIXTH

COURSE TITLE: INTERNAL COMBUSTION ENGINES (PROFESSIONAL ELECTIVE - 2)		
Sub Code: 18ME643	**No of Credits: L-T-P-SS 03:00:00:00 =03**	**No. of lecture hours/week: 03 Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 100**
Pre-requisites	**Basic and Applied Thermodynamics**	

COURSE OBJECTIVES:

1. To understand the basic principle of thermodynamic process
2. To understand the basic components and structure of IC engines (both SI and CI engines), process parameters.
3. Understanding the performance of the engine, combustion and exhaust parameters.

UNIT NO.	CONTENTS	Hrs.
1	**REVIEW OF I.C. ENGINE CYCLES AND CARBURETION** (BLENDED MODE)	**07**
	Review of thermodynamics cycles used in IC engines; Introduction to carburetion, air-fuel mixture requirement at different loads and speeds, Automotive air-fuel mixture requirement, principle of carburetion, simple carburettor, calculation of air-fuel ratio, essential parts of a carburettor, compensating devices, additional systems in modern carburettors, types of carburettors, automobile carburettors, altitude compensation, Numerical problems air-fuel mixture and carburetion.	
2	**MECHANICAL AND ELECTRONIC INJECTION SYSTEMS** (CLASSROOM MODE)	**09**
	Introduction to mechanical injection system; Functional Requirements of an Injection System; Classification of Injection Systems; Fuel Feed Pump, Injection Pump - Jerk Type Pump, Distributor Type Pump; Injection Pump Governor, Mechanical Governor; Pneumatic Governor; Fuel Injector; Nozzle - Types of Nozzle; Spray Formation, Quantity of Fuel and the Size of Nozzle Orifice; Injection in SI Engine; Introduction to electronic injection system; Gasoline injection - Types of Injection Systems, Components of Injection System; Electronic Fuel Injection System - Merits and Demerits of EFI System; Multi-Point Fuel Injection (MPFI) System; Functional Divisions of MPFI System; Injection Timing; Group Gasoline Injection System; Electronic Diesel Injection System; Electronic Diesel Injection Control; Numerical problems on mechanical injection system.	
3	**COMBUSTION IN SPARK IGNITION AND COMPRESSION IGNITIION ENGINES** (CLASSROOM MODE)	**09**
	Introduction; Homogeneous Mixture; Heterogeneous Mixture; Combustion in Spark–Ignition Engines; Stages of Combustion in SI Engines; Flame Front Propagation; Factors Influencing the Flame Speed; Rate of Pressure Rise; Abnormal Combustion; The Phenomenon of Knock in SI Engines, Effect of Engine Variables on Knock; Combustion Chambers for SI Engines; Combustion in Compression-Ignition Engines; Stages of Combustion in CI Engines; Factors Affecting the Delay Period; The Phenomenon of Knock in CI Engines; Comparison of Knock in SI and CI Engines; Combustion Chambers for CI Engines.	
4	**ENGINE ELECTRONICS AND SUPERCHARGING** (CLASSROOM MODE)	**07**

	Introduction; Typical Engine Management Systems; Different types of Position Displacement and Speed, Pressure, Temperature, Intake air flow and Exhaust oxygen measurement sensors and transducers; Supercharging – Introduction; Types Of Superchargers – Centrifugal, Root's and Vane Type; Methods of Supercharging - Electric Motor Driven, Ram Effect, Under Piston, and Kadenacy System of Supercharging; Effects of Supercharging; Limitations to Supercharging; Thermodynamic Analysis of Supercharged Engine Cycle; Power Input for Mechanical Driven Supercharger; Gear Driven and Exhaust Driven Supercharging Arrangements; Turbocharging - Charge Cooling; Numerical problems on supercharged engines.	
5	**NON CONVENTIONAL ENGINES** (ONLINE MODE)	**07**
	Introduction; Comprehensive study on working principle, thermodynamic analysis, design, types, advantages and disadvantages of the following types of engines - Common Rail Direct Injection Engine; Dual Fuel and Multi-Fuel Engines; Multi-fuel Engines; Gasoline Direct Injection Engine; Homogeneous Charge Compression Ignition (HCCI) Engine; Lean Burn Engine; Stirling Engine; Stratified Charge Engine; Variable Compression Ratio Engine; Wankel Engine; Hybrid electric vehicle (HEV), Introduction to Electric Vehicle Propulsion Systems, Motors and Controls for Electric Vehicles Applications, Storage technologies for EV, Battery pack and battery management system, Solar powered EVs.	

TEXT BOOKS

1. **Internal Combustion Engines**, V. Ganesan, Tata Mc-Graw Hill Publications,4th Edition, 2012.
2. **A Text Book of Internal Combustion Engines**, R.K. Rajput, Laxmi Publishers, 2007.
3. **Internal Combustion Engines**, M. L. Mathur and R. P. Sharma, Dhanpat Rai Publications, 2014.

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REFERENCE BOOKS

1. **Internal Combustion Engine Fundamentals**, John B. Heywood, Mc-Graw Hill Education India Limited, 2011.
2. **Engineering Fundamentals of the Internal Combustion Engines,** WillardW Pulkrabek. Pearson Education, 2^{nd} Edition, 2015.

COURSE OUTCOMES: On completion of the course, student should be able to:
CO1: Describe the carburetion and working principle of different type of carburettor. (RBTL: 1, 2, 3)
CO2: Explain the fuel injection systems in IC engines. (RBTL: 1, 2, 3)
CO3: Describe the combustion process and select suitable combustion chambers for IC engines. (RBTL: 1, 2, 3)
CO4: Understand the engine electronics and supercharging and solve problems on supercharged engines. (RBTL: 1, 2, 3)
CO5: Differentiate and select non-conventional engines in the context of modern developments. (RBTL: 1, 2, 3)
(RBTL: Revised Bloom's Taxonomy Levels; 1 – Remembering, 2 – Understanding, 3 – Applying, 4 - Analyzing, 5 - Evaluating, 6 - Creating)

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	0	2	0	0	0	0	0	0	2
CO2	3	3	2	0	2	0	2	0	0	0	0	2
CO3	3	3	2	0	2	0	0	0	0	0	0	2
CO4	3	3	3	3	3	0	0	0	0	2	0	2
CO5	3	3	2	1	3	3	3	0	0	2	0	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR :	**2018-19**	**ACADEMIC YEAR:**	**2020-21**
SEMESTER :	**SIXTH**		

COURSE TITLE : PRODUCTION AND OPERATIONS MANAGEMENT (PROFESSIONAL ELECTIVE - 2)		
Sub Code: 18ME644	**No of Credits =03** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 100**
Pre-requisites	Elementary knowledge of calculus and probability	

Course Objective:

1. Develop an understanding of and an appreciation for the production and operations management function in any organization.
2. To understand the importance of productivity and competitiveness to both organizations and nations.
3. To understand the importance of an effective production and operations strategy to an organization.
4. To understand the various production and operations design decisions and how they relate to the overall strategies of organizations.
5. To understand the relationship of the various planning practices of capacity planning, aggregate planning, project planning and supply management.

UNITS	CONTENTS	Hrs.
UNIT- 1	**PRODUCTION & OPERATIONS MANAGEMENT CONCEPTS** (ONLINE TEACHING)	**08**
	Introduction, Historical Development, Operations Management Definition, Production and Manufacturing Systems, Products v/s Services, Productivity, Factors affecting Productivity, International Dimensions of Productivity, The environment of operations, Operational excellence and world class manufacturing practices. OPERATIONS DECISION MAKING: Introduction, Characteristics of decisions, framework for Decision Making, Decision methodology, Decision supports systems, Economic models, Statistical models. (Simple numericals)	
UNIT- 2	**SYSTEM DESIGN & CAPACITY PLANNING**(BLENDED TEACHING)	**08**
	Design capacity, System capacity, and Determination of Equipment requirement. Facility Location and Facility Layout, Location Planning for Goods and Services, Foreign locations and facility layout. (Simple numericals)	
UNIT- 3	**FORECASTING, AGGREGATE PLANNING AND MASTER SCHEDULING**(ONLINE TEACHING)	**08**
	Forecasting: Forecasting Objectives and Uses, Forecasting Variables, Opinion and Judgmental methods, Time Series methods, Exponential smoothing, Regression and Correlation methods, Application and Control of Forecasts. (Simple numericals) **Aggregate Planning And Master Scheduling:** Introduction, Planning and Scheduling, Objectives of Aggregate Planning, Aggregate Planning Methods, Master Scheduling Objectives, Master Scheduling Methods. (Simple numericals)	
UNIT- 4	**INVENTORY CONTROL AND MATERIALS MANAGEMENT** (ONLINE TEACHING)	**08**
	Definition and Need, Components Inventory, inventory control. Scope of Materials	

	Management, Material handling, storage and retrieval, purpose of inventories, Dependent and Independent demand, Inventory cost and Order quantities, Inventory classification and counting (Simple numericals)	
UNIT- 5	**MATERIAL, CAPACITY REQUIREMENTS PLANNING AND PURCHASING & SUPPLY MANAGEMENT** (CLASS ROOM TEACHING)	**07**
	Material and Capacity Requirements Planning: Overview: MRP and CRP, MRP: Underlying Concepts, System Parameters, MRP Logic, System refinements, Capacity Management, CRP activities. Concept of continuous improvement of process. (Simple numericals) **Purchasing & Supply Management**: Purchase and supply chain management. Approaches to purchase and supply chain management, make or buy decision, eProcurement, Vender development, rating, and certification.	

TEXT BOOKS:
1. Operations Management, I. B. Mahadevan. Theory and practice, Pearson, 2007.
2. Operations Management, Monks, J.G., McGraw-Hili International Editions, 1987.

REFERENCE BOOKS:
1. Modern Production/Operations Management, Buffa, Wiley Eastern Ltd.2001
2. Production and Operations Management, Pannerselvam. R., PHI. 2002
3. Productions & Operations Management, Adam & Ebert. 2002
4. Production and Operations Management, Chary, S. N., Tata-McGraw Hill. 2002

COURSE OUTCOMES: On completion of the course, student should be able to:
CO1: Appreciate the production and operations management function in any organization.
CO2: Explain importance of productivity and competitiveness to both organizations and nations.
CO3: Explain importance of an effective production and operations strategy to an organization.
CO4: Explain various production and operations design decisions and how they relate to the overall strategies of organizations.
CO5: Explain relationship of the various planning practices of capacity planning, aggregate planning, project planning and supply management.

MAPPING OF COs WITH POs												
COs/POs	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	0	2	0	0	0	0	0	0	2
CO2	3	3	2	1	2	0	2	0	0	0	0	2
CO3	3	3	2	1	2	0	0	0	0	0	0	2
CO4	3	3	3	3	2	2	0	0	0	2	0	2
CO5	3	3	2	1	3	3	3	0	0	2	0	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2017-18 ACADEMIC YEAR: 2019-20

SEMESTER : SIXTH

COURSE TITLE : FINITE ELEMENT METHODS (PROFESSIONAL ELECTIVE – 2)		
Sub Code: 18ME645	**No of Credits =03** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Engineering mathematics, MOM, DOM**	

COURSE OBJECTIVES:

1. To impart structures analysis for stress, strain & dynamic loading knowledge
2. To enable formulation of the dimensional structure, mechanical and thermal problems into FEA.
3. To comprehend the basic concepts and enhance capabilities for solving 2 D complex problems.
4. To introduce the concepts of elastic and static analysis problems.

#	CONTENTS	Hrs.
UNIT-1	**INTRODUCTION** (BLENDED TEACHING)	**10**
	General description of Finite Element Method, Geometry, Elements, Node Numbering Schemes, Application and limitations. Equilibrium equations in elasticity. Definitions of FEA and FDM. **Interpolation and One – Dimensional Problems** Euler – Lagrange's equation for bar, beam (cantilever / simply supported fixed) Principle of virtual work, principle of minimum potential energy, Raleigh's Ritz method and Galerkin's method boundary conditions. Interpolation polynomials- Linear, quadratic and cubic, 2D PASCAL's triangle. CST elements-Shape functions. Solutions of bars and stepped bars for displacements, reactions and stresses by using penalty approach and elimination approach. Guass-elimination technique. Applications.	
UNIT-2	**HIGHER ORDER ELEMENTS** (ON-LINE TEACHING)	**08**
	Lagrange's interpolation, Higher order one dimensional elements-Quadratic and cubic element and their shape functions. Shape function of 2-D quadrilateral element-linear, quadric element Iso-parametric, Sub parametric and Super parametric elements.	
UNIT-3	**TRUSSES** (CLASS ROOM TEACHING)	**06**
	2D truss Elements Stiffness matrix of Truss element. Examples illustrating how to obtain various internal force diagrams for different types of structural member like trusses Numerical problems.	
UNIT-4	**BEAMS** (CLASS ROOM TEACHING)	**08**
	Governing Differentia Equation for beam bending Hermite shape functions for beam element, Derivation of stiffness matrix. Numerical problems of beams carrying concentrated, UDL and linearly varying loads.	
UNIT-5	**THERMAL ANALYSIS** (CLASS ROOM TEACHING)	**07**
	Steady state Heat Transfer, One Dimensional Heat Conduction – Governing Equation – Boundary Condition. Temperature Gradient & B matrix functional approach to Heat Conduction – Element Conductivity Matrix. Assembly & Boundary Conditions, Heat Flux Boundary Conditions, Forced and Natural Boundary Conditions – Numerical problems. Simple Problems.	

TEXT BOOKS:

1. **Finite Elements in Engineering**, T.R.Chandrupatla, A.D Belegunde, 3rd Ed PHI.
2. **Finite Element Method in Engineering**, S.S. Rao, 4th Edition, Elsevier, 2006.
3. **Fundamentals of Finite Element Method** by Dr. S. M. Murigendrappa, International Publication – 2nd Edition 2009.
4. **Finite Element Methods by S .B. Halesh , Sapna Book House - Bangalore.**

REFERENCE BOOKS:

1. **"Finite Element Methods for Engineers"** U.S. Dixit, Cengage Learning, 2009.
2. **Concepts and applications of Finite Element Analysis**, R.D. Cook D.S Maltus, M.E Plesha, R.J.Witt, Wiley 4th Ed, 2009
3. **Finite Element Methods**, Daryl. L. Logon, Thomson Learning 3rd edition, 2001.
4. **Finite Element Method**, J.N. Reddy, McGraw -Hill International Edition.

COURSE OUTCOMES: on completion of the course, student should be able to:

CO1: Understand the fundamental concepts of FEM and develop an ability to generate the governing FE equations for systems governed by partial differential Equations.

CO2: Understand the concept of shape and interpolation function for higher order elements.

CO3: Understand and analyze the structural applications of trusses.

CO4: Gain the knowledge and able to do analysis of beam structure subjected to different loading conditions.

CO5: Obtain the ability to understand heat conduction, heat flux and apply the boundary conditions with analysis to solve numerical problems.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	2	1	1	2	2	2	0	3
CO2	3	3	2	3	2	1	1	2	2	2	0	3
CO3	3	3	3	3	2	1	1	2	2	2	0	3
CO4	3	3	2	3	2	1	1	2	2	2	0	3
CO5	3	3	3	3	2	2	1	2	2	2	0	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2018-19 ACADEMIC YEAR: 2020-21
SEMESTER : SIXTH

COURSE TITLE : FLUID POWER CONTROL SYSTEMS (PROFESSIONAL ELECTIVE – 1)		
Sub Code: 18ME646	**No of Credits : L-T-P-SS 3:0:0:0 =3**	**No. of lecture hours/week : 03** **Total Number of Contact Hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Fluid mechanics**	

COURSE OBJECTIVES:

1. To outline the introductory concepts on fluid power control systems.
2. To explain various types of hydraulic pumps and actuators, and their classification and application.
3. To describe the operation of a complete hydraulic circuit drawn with symbols for all components.
4. To outline the basics of a pneumatic system with its components.
5. To describe the pneumatic control system and various logic devices and pneumatic circuits.

#	CONTENTS	Hrs.
UNIT-1	**INTRODUCTION TO FLUID POWER CONTROL** (BLENDED MODE)	**06**
	Review of fluid mechanics (Pascal's law, continuity equation, Bernoulli's equation, Torricelli theorem, Air-to-hydraulic pressure booster, the siphon); Introduction to fluid power: advantages and applications; Types of fluid power control systems: Environmental issues; Fluids in hydraulic system: fluid properties, general types of fluids; Seals, sealing materials and compatibility with fluids; pipe sizing for flow rate and pressure rating requirement, different pipes, tubing and hoses, quick disconnect couplings; Flow through pipes: Laminar and turbulent, Reynolds number, Darcy equation, frictional losses, equivalent thickness technique; Numerical problems.	
UNIT-2	**HYDRAULIC PUMPS AND ACTUATORS** (CLASSROOM MODE)	**09**
	Introduction, Pumping theory, Classification of pumps, construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps, Pump performance characteristics, pump noise, pump selection factors; Accumulators: Types, and applications of accumulators; Types of Intensifiers; Pressure switches /sensor, Temperature switches/sensor, Level sensor; Actuators: Classification, cylinder and hydraulic motors, Hydraulic cylinders, single and double acting cylinder, mounting arrangements, cushioning, special types of cylinders; Construction and working of rotary actuators such as gear, vane, piston motors, and Hydraulic Motor. Theoretical torque, power, flow rate, and hydraulic motor performance; Symbolic representation of hydraulic actuators (cylinders and motors); Numerical problems.	
UNIT-3	**HYDRAULIC CIRCUIT DESIGN AND ANALYSIS** (CLASSROOM MODE)	**09**
	Components and hydraulic circuit design Components: Classification of control valves, Directional Control Valves-symbolic representation, constructional features of poppet, sliding spool, rotary type valves solenoid and pilot operated DCV, shuttle valve, and check valves; Pressure control valves - types, direct operated types and pilot operated types; Flow Control Valves -compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation; Hydraulic Circuit Design: Control of single and Double -acting hydraulic cylinder, regenerative circuit, pump unloading circuit, counter balance valve application,	

	hydraulic cylinder sequencing circuits, hydraulic circuit for force multiplication; speed control of hydraulic cylinder- metering in, metering out and bleed off circuits. Pilot pressure operated circuits; Hydrostatic transmission; Numerical problems.	
UNIT-4	**INTRODUCTION TO PNEUMATIC CONTROL** (CLASSROOM MODE)	**09**
	Definition of pneumatic system, advantages, limitations, applications, Choice of working medium. Characteristic of compressed air. Structure of Pneumatic control System, fluid conditioners and FRL unit. **PNEUMATIC ACTUATORS:** Linear cylinder - types, conventional type of cylinder r-working, end position cushioning, seals, mounting arrangements- applications. Rod - less cylinders types, working, advantages, rotary cylinders- types construction and application, symbols. **COMPRESSED AIR:** Production of compressed air- preparation of compressed air-driers, filters, regulators, lubricators, distribution of compressed air piping layout.	
UNIT-5	**PNEUMATIC CONTROL VALVES AND CIRCUITS** (ONLINE MODE)	**06**
	DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve, quick exhaust valve, time delay valve, shuttle valve, twin pressure valve, symbols. simple pneumatic control: direct and indirect actuation pneumatic cylinders, speed control of cylinders - supply air throttling and exhaust air throttling. **SIGNAL PROCESSING ELEMENTS:** Use of Logic gates - OR and AND gates in pneumatic applications. Practical Examples involving the use of logic gates, Pressure dependant controls- types - construction - practical applications, Signal elimination and cascading methods, Time dependent controls principle. Construction, practical applications. **ELECTRO-PNEUMATIC CONTROL:** Principles - signal input and output, pilot assisted solenoid control of directional control valves, relay and contactors. Control circuitry for simple signal cylinder application. Numerical problems on pneumatic circuits.	

TEXT BOOKS

1. **Fluid Power with Applications,** Anthony Esposito, Pearson, 7th Edition, 2013**.**
2. **Hydraulics and Pneumatics,** Andrew Par, Jaico Publishing House, 2005.
3. **Fluid Power: Theory and Applications**, James Sullivan, 3rd Edition, Prentice Hall, 1989.

REFERENCE BOOKS

1. **Oil Hydraulics,** Majumdar, S.R., Tata McGraw-Hill Publications, 2002.
2. **Pneumatic Systems: Principles and Maintenance,** Majumdar, S.R., Tata McGraw-Hill Publications, 2005
3. **Fundamentals of Fluid Power Control,** John Watton, Cambridge University Press, 2012..

COURSE OUTCOMES: On completion of the course, students will be able to:
CO1: *Understand* the fundamental theoretical concepts governing the fluid power. (RBTL: 1, 2, 3)
CO2: *Familiarize* with common hydraulic components (such as pumps, actuators, motors, and valves), their use, symbols and their performance characteristics. (RBTL: 1, 2, 3)
CO3: *Formulate* and *analyse* mathematical models of hydraulic circuits and design them for directional, speed, pressure, force and flow control. (RBTL: 1, 2, 3)
CO4: *Understand* the basics of the structure of a pneumatic system and its components. (RBTL: 1, 2, 3)

CO5: *Familiarize* with the pneumatic control valves and circuits, signal processing elements and electro-pneumatic control circuits. (RBTL: 1, 2, 3)
(RBTL: Revised Bloom's Taxonomy Levels; 1 – Remembering, 2 – Understanding, 3 – Applying, 4 - Analyzing, 5 - Evaluating, 6 - Creating)

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	0	2	0	0	0	0	0	0	2
CO2	3	3	2	0	2	0	2	0	0	0	0	2
CO3	3	3	2	0	2	0	0	0	0	0	0	2
CO4	3	3	3	3	3	0	0	0	0	2	0	2
CO5	3	3	2	1	3	3	3	0	0	2	0	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										
3. Each full question shall have maximum of 3 sub-divisions										

ADMISSION YEAR : 2018-19 ACADEMIC YEAR: 2020-21
SEMESTER : SIXTH

COURSE TITLE : FLUID MECHANICS AND MACHINES LABORATORY		
Sub Code: 18MEL65	**No of Credits : L-T-P-SS 0:0:2:0 = 1**	**No. of practical hours/week: 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 50**
Pre-requisites	**Fluid Mechanics, Turbomachines**	

COURSE OBJECTIVES:

1. To conduct experiment to determine coefficient of impact of water jet on vanes.
2. To determine coefficient of discharge of orifice meter, venturimeter and V-notch.
3. To conduct experiment to determine major loss of head in flow through a pipe.
4. To conduct performance test on Pelton, Francis and Kaplan turbines and evaluate the efficiency of these turbines.
5. To determine the efficiency of single stage and multi stage centrifugal pump and plot the characteristic curves; to conduct performance test on reciprocating pump and determine the percentage slip.

#	CONTENTS	Hrs.
UNIT-1	**MINOR EXPERIMENT**	**10**
	1) Impact of jet on vanes - Determination of coefficient of impact of water jet on flat vane, inclined vane and hemispherical vane. 2) Orifice meter – Determination of coefficient of discharge (Calibration of orifice meter) 3) Venturimeter – Determination of coefficient of discharge (Calibration of venturimeter) 4) V- notch – Determination of coefficient of discharge (Calibration of V notch) 5) Flow through a pipe - Determination of major losses.	
UNIT-2	**MAJOR EXPERIMENT**	**12**
	I. Performance testing, plotting the characteristic curves and determination of unit quantities and specific speed of 1) Pelton turbine 2) Francis turbine 3) Kaplan turbine **II.** Performance testing, plotting the characteristic curves and determination of specific speed of 4) Single stage centrifugal pump 5) Multi stage centrifugal pump **III.** Coefficient of discharge and percentage slip of a reciprocating pump.	

REFERENCE BOOKS

1) **Hydraulics and Fluid Mechanics including Hydraulic Machines**, Dr. P.N. Modi and S.M. Seth, Rajsons Publications Private Limited, Standard Book House, 2009.

COURSE OUTCOMES: After completion of the course, students will be able to:
CO1: Determine the coefficient of impact of jet on flat, inclined and hemispherical vanes.
CO2: Conduct the experiments on orifice meter, venturimeter and V-notch to calibrate them and determine their coefficient of discharge; determine the loss of head due to friction in pipes of different diameters.

CO3: Demonstrate the working of Pelton, Francis and Kaplan turbines and plot their operating characteristic curves by conducting performance test on them.
CO4: Conduct the performance test on single and four stage centrifugal pumps to plot their characteristic curves.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1	3	1	1	1	1	1	1	1	1	1
CO2	1	1	3	1	1	1	1	1	1	1	1	1
CO3	1	1	3	1	1	1	1	1	1	1	1	1
CO4	3	3	1	1	1	1	1	1	1	1	1	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

SCHEME OF EXAMINATION (SEE)					
Sl. No.	**Particulars**	**Max. Marks**	**Break Up of Max. Marks**		
			Write Up	**Conduction of experiment**	**Specimen Calculation, Tabulation of Results and Plotting of Graph**
1	**Unit-1: Minor Experiment** (Any ONE from the list of experiments)	**15**	05	05	05
2	**Unit-2: Major Experiment** (Any ONE from the list of experiments)	**25**	05	10	10
3	Viva Voce	**10**	--	--	--
	TOTAL MARKS	**50**	**10**	**25**	**15**

ADMISSION YEAR : 2018-19 **ACADEMIC YEAR: 2020-21**
SEMESTER : SIXTH

COURSE TITLE : HEAT TRANSFER LABORATORY		
Sub Code: 18MEL66	**No of Credits : L-T-P-SS 0:0:2:0 = 1**	**No. of practical hours/week: 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 50**
Pre-requisites	**Basic Thermodynamics, Fluid Mechanics, Heat Transfer**	

COURSE OBJECTIVES:

1. To understand the basic conduction, convection and radiation heat transfers.
2. To study combined conduction and convection states of heat transfer.
3. To determine emissivity of a grey body and verify Stefan Boltzmann constant.
4. To determine effectiveness of parallel flow and counter flow heat exchangers.
5. To conduct tests on vapor compression refrigeration.

#	CONTENTS	Hrs.
UNIT-1	**MINOR EXPERIMENT**	**10**
	1. Composite wall - Determination of overall heat transfer coefficient of a composite wall. 2. Metal rod - Determination of thermal conductivity of a metal rod. 3. Fin – Determination of efficiency and effectiveness of a fin free convection mode. 4. Emissivity - Determination of emissivity of a given grey surface	
UNIT-2	**MAJOR EXPERIMENT**	**16**
	1. Vertical pipe - Determination of heat transfer coefficient in free convection mode. 2. Pipe flow - Determination of heat transfer coefficient in forced convection mode for hot air flowing through a circular pipe. 3. Stefan Boltzmann constant - Verification of Stefan Boltzmann Constant. 4. Fin - Determination of efficiency and effectiveness of a fin in forced convection mode. 5. Shell and Tube heat exchanger - Determination of Log Mean Temperature Difference (LMTD) and Effectiveness in (i) Parallel Flow mode and (ii) Counter Flow mode 6. Vapour Compression Refrigerator (VCR) – Determination of COP.	

REFERENCE BOOKS

1. **Heat and Mass Transfer,** P.K. Nag, 3rd Edition, Tata McGraw-Hill, 2011.
2.A Course in Heat and Mass Transfer, Domkundwar, Arora, Domkundwar, Dhanpat Rai Publications, 2005.
3. Basic and Applied Thermodynamics, P.K. Nag, Tata McGraw-Hill Publications, 2nd Edition, 2010.

COURSE OUTCOMES: After completion of the course, students will be able to:
CO1: Conduct the experiments on conduction heat transfer.
CO2: Demonstrate the working of test rigs on convection heat transfer.
CO3: Illustrate the procedure and demonstrate the experiments on radiation heat transfer.
CO4: Calculate the thermal conductivity heat transfer coefficient, Stefan Boltzmann constant and performance parameters related to the conduction, convection and radiation heat transfer after conducting the experiments.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1	3	1	1	1	1	1	1	1	1	1
CO2	1	1	3	1	1	1	1	1	1	1	1	1
CO3	1	1	3	1	1	1	1	1	1	1	1	1
CO4	3	3	1	1	1	1	1	1	1	1	1	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

SCHEME OF EXAMINATION (SEE)					
Sl. No.	**Particulars**	**Max. Marks**	**Break Up of Max. Marks**		
			Write Up	**Conduction of experiment**	**Specimen Calculation, Tabulation of Results and Plotting of Graph**
1	**Unit-1: Minor Experiment** (Any ONE from the list of experiments)	**15**	05	05	05
2	**Unit-2: Major Experiment** (Any ONE from the list of experiments)	**25**	05	10	10
3	Viva Voce	**10**	--	--	--
	TOTAL MARKS	**50**	**10**	**25**	**15**

ADMISSION YEAR : 2018-19 ACADEMIC YEAR: 2020-21
SEMESTER : SIXTH

COURSE TITLE : MINI - PROJECT WORK		
Sub Code: 18MEP67	**No of Credits =02 L-T-P-SS::0:0:4:0**	**No. of contact hours/week : 04**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 50**

COURSE OBJECTIVES:
1. To instill an atmosphere in students to find a working situation and discover the workable area.
2. To insure a transition from planned laboratory course to planning one independently.

CONTENTS
FABRICATION, MODELING & ANALYSIS
Students have to make simple projects with fabrication related to mechanical projects on a mini scale and/or projects using Modeling and analysis tools project related to realistic problems of mechanical stream

COURSE OUTCOMES: On completion of the course, student should be able to:
CO1: Literature review on national and international journals and define the problem.
CO2: Design Experiments scientifically / Perform Numerical Analysis / Develop Analytical models to Interpret the Results and Prepare quality document

MAPPING OF COs WITH POs												
COS/POS	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	2	1	1	1	1	2	1	1
CO2	3	3	2	1	2	1	1	1	1	2	1	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

SCHEME OF VALUATION:
Departments shall constitute a Departmental Project Review Committee (faculty + guide)
Project evaluation shall be done by the departmental committee along with the guide and the marks shall be submitted to exam section.
CIE-1: project evaluation in the middle of the semester for 25 marks.
CIE-2: project evaluation at the end of the semester for 25 marks.
SEE: evaluation by both internal and external examiners for 50 marks by conducting project viva-voce.

GUIDELINES FOR PREPARING PROJECT REPORT

1. Project reports should be typed neatly only on one side of the paper with 1.5 or double line spacing on an A4 size bond paper (210 x 297 mm).
2. **The margins should be:** Left – 1.25″, Right – 1″, Top and Bottom – 0.75″.
3. The total number of reports to be prepared are
   i) A copy to the department library
   ii) A copy to the concerned guide(s)
   iii) Two copies to the sponsoring agency
   iv) Candidate’s copy.

4. Before taking the final printout, the approval of the **concerned guide(s) is mandatory** with suggested corrections, if any, to be incorporated.
5. For making copies dry tone Xerox is suggested. Every copy of the report must contain Inner title page (White) Outer title page with a plastic cover Certificate in the format enclosed both from the college and the organization where the project is carried out.
6. An **abstract (synopsis)** not exceeding 100 words, indicating salient features of the work. (NB: four copies of the abstract are to be submitted to the Department on the date of submission separately)
7. The organization of the report should be as follows
   i) Inner title page
   ii) Abstract or Synopsis
   iii) Acknowledgments
   iv) Table of Contents
   v) List of table & figures (optional)
   vi) Usually numbered in roman
   vii) Chapters (to be numbered in Arabic) containing Introduction-, which usually specifies the scope of work and its importance and relation to previous work and the present developments, Main body of the report divided appropriately into chapters, sections and subsections.
   viii) The chapters, sections and subsections may be numbered in the decimal form for e.g. Chapter 2, sections as 2.1, 2.2 etc., and subsections as 2.2.3, 2.5.1 etc.
   ix) The chapter must be left or right justified (font size 16). Followed by the title of chapter centered (font size 18), section/subsection numbers along with their headings must be left justified with section number and its heading in font size 16 and subsection and its heading in font size 14. The body or the text of the report should have font size 12.
   x) The figures and tables must be numbered chapter wise for e.g.: Fig. 2.1 Block diagram of a serial binary adder, Table 3.1 Primitive flow table, etc.
   xi) The last chapter should contain the summary of the work carried, contributions if any, their utility along with the scope for further work.
   xii) **Reference OR Bibliography:** The references should be numbered serially in the order of their occurrence in the text and their numbers should be indicated within square brackets for e.g. [3]. The section on references should list them in serial order in the following format.
   For textbooks – A.V. Oppenheim and R.W. Schafer, Digital Signal Processing, Englewood, N.J., Prentice Hall, 3 Edition, 1975.
   For papers – Devid, Insulation design to combat pollution problem, Proc of IEEE, PAS, Vol 71, Aug 1981, pp 1901-1907.

8. Only SI units are to be used in the report. Important equations must be numbered in decimal form for e.g.

   V = IZ ………. (3.2)

   All equation numbers should be right justified.
9. The project report should be brief and include descriptions of work carried out by others only to the minimum extent necessary. Verbatim reproduction of material available elsewhere should be strictly avoided. Where short excerpts from published work are desired to be included, they should be within quotation marks appropriately referenced. Proper attention is to be paid not only to the technical contents but also to the organization of the report and clarity of the expression. Due care should be taken to

avoid spelling and typing errors. The student should note that report-write-up forms the important component in the overall evaluation of the project

10. Hardware projects must include: the component layout, complete circuit with the component list containing the name of the component, numbers used, etc. and the main component data sheets as Appendix.
11. At the time of report submissions, the students must hand over a copy of these details to the project coordinator and see that they are entered in proper registers maintained in the department.
12. Software projects must include a virus free disc, containing the software developed by them along with the read me file. Read me file should contain the details of the variables used, salient features of the software and procedure of using them: compiling procedure, details of the computer hardware/software requirements to run the same, etc. If the developed software uses any public domain software downloaded from some site, then the address of the site along with the module name etc. must be included on a separate sheet. It must be properly acknowledged in the acknowledgments.
13. Sponsored Projects must also satisfy the above requirements along with statement of accounts, bills for the same dully attested by the concerned guides to process further, They must also produce NOC from the concerned guide before taking the internal viva examination.
14. The reports submitted to the department/guide(s) must be hard bounded, with a plastic covering.
15. Separator sheets, used if any, between chapters, should be of thin paper.

COLOUR OF THE OUTER COVER/FRONT PAGE OF UG DISSERTATION / PROJECT REPORT - SKY BLUE

Dr. AMBEDKAR INSTITUTE OF TECHNOLOGY

(An autonomous institution, Aided by Govt. of Karnataka, Affiliated to VTU)
BDA Outer Ring Road, Near Jnana Bharathi Campus, Bengaluru - 560056

Department of Mechanical Engineering

CERTIFICATE

Certified that the Mini project work (Sixth Semester) entitled…………………………………… is carried out by the following bonafide students of Mechanical Engineering in partial fulfillment for the award of Bachelor of Engineering, B. E (Mechanical) at **Dr. Ambedkar Institute of Technology, Bangalore,** during the academic year ....

Sl. No	**U S N** (ascending order)	**Name of Student**

It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the project report.

The project report has been approved satisfying the academic requirements prescribed for the said Degree.

Guide	**HOD**	**Principal**

External Viva:

Sl. No	Name of the examiner	Signature with date
1		
2		

ADMISSION YEAR : 2018-19 **ACADEMIC YEAR: 2020-21**

SEMESTER : SIXTH

COURSE TITLE : INDUSTRY INTERNSHIP		
Sub Code: 18MEI68	**No of Credits =00** **L-T-P-SS::0:0:2:0**	

Internship: All the students admitted to III year of BE/B. Tech have to undergo mandatory internship of 4 weeks during the vacations of VI and VII semesters and /or VII and VIII semesters. A University examination will be conducted during VIII semester and prescribed credit are added to VIII semester. Internship is considered as a head of passing and is considered for the award of degree. Those, who do not take-up/complete the internship will be declared as failed and have to complete during subsequent University examination after satisfy the internship requirements.

SEVENTH SEMESTER (BATCH 2017-21)

			L	T	P	C
1	HS04**	INTELLECTUAL PROPERTY RIGHTS	02	00	00	2.0
2	INTER – DEPARTMENTAL ELECTIVE / INSTITUTIONAL ELECTIVE		04	00	00	4.0
3	ME71	CONTROL ENGINEERING	04	00	00	4.0
4	ME72	HYDRAULICS & PNEUMATICS	04	00	00	4.0
5	ME73X	PROFESSIONAL ELECTIVES – 5	03	00	00	3.0
6	MEL74	COMPUTER AIDED MODELING AND ANALYSIS LABORATORY	00	02	02	2.0
7	MEP75	PROJECT WORK PHASE – I	00	00	04	0.0
					SEVENTH SEMESTER END CREDITS	**19.0**

PROFESSIONAL ELECTIVES – 5

5	ME731	RAPID PROTOTYPING	03	00	00	3.0
	ME732	INTERNAL COMBUSTION ENGINES	03	00	00	3.0
	ME733	ENGINEERING ECONOMICS	03	00	00	3.0

EIGHTH SEMESTER (BATCH 2017-21)

			L	T	P	C
1	ME81X	PROFESSIONAL ELECTIVE – 6	03	00	00	3.0
2	MEL82	CONTROL ENGINEERING LABORATORY	00	01	01	1.0
3	MES83	SEMINAR	00	00	04	2.0
4	MEP84	PROJECT WORK PHASE – II	00	00	12	12.0
					EIGHTH SEMESTER END CREDITS	**18.0**
					FOURTH YEAR CREDITS	**37.0**
					CUMULATIVE CREDITS AT END OF 4th YEAR	**200.0**

PROFESSIONAL ELECTIVE – 6						
6	ME811	COMPUTER INTEGRATED MANUFACTURING	03	00	00	3.0
	ME812	COMPUTATIONAL FLUID DYNAMICS	03	00	00	3.0
	ME813	SMART MATERIALS	03	00	00	3.0

EQUIVALENT COURSES FOR THE STUDENTS ADMITTING TO 7TH AND 8TH SEMESTER B.E IN MECHANICAL ENGINEERING

Equivalent Courses for the students admitting with backlogs from the previous academic years to the current academic year 2020-21 will be recommended by their respective mentor, BOS members and chairman.

ADMISSION YEAR : 2017-18 ACADEMIC YEAR: 2020-21
SEMESTER : SEVENTH

COURSE TITLE : CONTROL ENGINEERING		
Sub Code: ME71	**No of Credits =04** **L-T-P-SS::4:0:0:0**	**No. of lecture hours/week : 04** **Total Number of Lecture hours : 52**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 100**
Pre-requisites	**Engineering mathematics**	

COURSE OBJECTIVES:

1. Mathematical modeling of the mechanical systems using differential equations.
2. Deduction of Transfer functions using block Diagrams and signal flow graphs
3. Emphasize on transient characteristics and response of the systems and Routh-Hurwitz stability criteria
4. Analysis of frequency response characteristics of control systems.
5. Construction of root locus plots and to ascertain the stability of the control systems

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#	CONTENTS	Hrs
UNIT-1	**MECHANICAL CONTROL SYSTEMS** (ONLINE TEACHING)	**10**
	Introduction to the Concept of automatic controls, open loop and closed loop control systems, concepts of feedback, requirements of an ideal control system. Mathematical models**:** Transfer function models, models of mechanical systems, feed forward systems with examples. Positive Feedback systems.	
UNIT-2	**BLOCK DIAGRAMS AND SIGNAL FLOW GRAPHS** (CLASSROOM TEACHING)	**10**
	Transfer Functions definition, function, blocks representation of systems elements, reduction of block diagrams, signal flow graphs: Mason’s gain formula.	
UNIT-3	**TRANSIENT AND STEADY STATE RESPONSE ANALYSIS** (BLENDED TEACHING)	**10**
	Introduction, first order and second order system response to step, ramp and impulse inputs, concepts of time constant and its importance in speed of response. System stability: Routh’s-Hurwitz criterion; types of controllers- proportional, integral proportional integral, proportional integral differential controllers.	
UNIT-4	**FREQUENCY RESPONSE ANALYSIS** (CLASSROOM TEACHING)	**12**
	Bode attenuation diagrams, stability analysis using bode plots, simplified bode diagrams. Polar plots, Nyquist stability criterion, Stability analysis, Relative stability concepts, Gain margin and phase margin, M &;N circles.	
UNIT-5	**ROOT LOCUS PLOTS** (CLASSROOM TEACHING)	**10**
	Root Loci; Definition, general rules for constructing and analysis using root locus plots.	

TEXT BOOKS:

1. **Modern Control Engineering,** Katsuhiko Ogatta, Pearson Education,2004.
2. **Control Systems Principles and Design,** M. Gopal, TMH,2000.

REFERENCE BOOKS:

1. **Modern Control Systems**, Richard.C.Dorf and Robert. H. Bishop, Addison Wesley,1999
2. **System dynamics & control**, Eronini-Umez,Thomson Asia pte Ltd. Singapore, 2002.
3. **Feedback Control System**, Schaum’s series. 2001.

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Describe fundamentals of control elements and mathematical modeling
CO2: To understand the block diagram and signal flow graphs.
CO3: Analyze steady state and transient response of first and second order systems.
CO4: Analyze system stability through Bode and Nyquist plots.
CO5: Construction and stability analysis using root locus plots.

MAPPING OF COs WITH POs												
COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	1	1	2	0	0	1	0	3
CO2	3	3	2	1	1	0	2	0	0	1	0	2
CO3	3	3	2	1	1	0	2	0	0	1	0	2
CO4	3	3	3	2	1	0	2	0	0	1	0	3
CO5	3	3	2	2	1	0	2	0	0	1	0	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2017-18 ACADEMIC YEAR: 2020-21
SEMESTER : SEVENTH

COURSE TITLE : HYDRAULICS AND PNEUMATICS		
Sub Code: ME72	**No of Credits : L-T-P-SS 04:00:00:00 =04**	**No. of lecture hours/week : 04 Total Number of Lecture hours : 52**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 100**
Pre-requisites	**Fluid mechanics, Applied thermodynamics**	

COURSE OBJECTIVES:
1. Impart the knowledge of basics of hydraulics.
2. Ability to identify components for the applications of hydraulic systems.
3. Learn and apply hydraulics circuits and design.
4. To impart the knowledge of pneumatics.
5. Ability to understand multidisciplinary systems like electro pneumatic controls in automation.

#	CONTENTS	Hrs
UNIT-1	**INTRODUCTION** (BLENDED TEACHING)	**10**
	INTRODUCTION TO HYDRAULIC POWER: Definition of hydraulic system, advantages, limitations, applications, Pascal's law, structure of hydraulic control system, problems on Pascal's law. **PUMPS:** Classification, pumping theory of positive displacement pumps, construction and working of gear pumps, vane pumps, piston pumps, fixed and variable displacement pumps, pump performance characteristics, pump selection factors.	
UNIT-2	**HYDRAULIC ACTUATORS AND MOTORS** (CLASSROOM TEACHING)	**10**
	Classification cylinder and hydraulic motors, linear hydraulic actuators [cylinders], single and double acting cylinder, mechanics of hydraulic cylinder loading, cushioning, special types of cylinders. **CONTROL COMPONENTS IN HYDRAULIC SYSTEMS:** Classification of control valves, directional control valves-ANSI Symbolic representation, constructional features of poppet, sliding spool, rotary type valves solenoid and pilot operated DCV, shuttle valve, check valves, pressure control valves - types, direct operated types and pilot operated types. Flow control valves - compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated pressure and temperature compensated FCV, symbolic representation.	
UNIT-3	**HYDRAULIC CIRCUIT ANALYSIS** (CLASSROOM TEACHING)	**10**
	Control of single and double acting hydraulic cylinder, regenerative circuit, pump unloading circuit, double pump hydraulic system, counter balance valve application, hydraulic cylinder sequencing circuits, automatic cylinder reciprocating system, locked cylinder using pilot check valve, cylinder synchronizing circuit using different methods, factors affecting synchronization, speed control of hydraulic motors, safety circuit, accumulators, types, construction and applications with circuits.	
UNIT-4	**INTRODUCTION TO PNEUMATIC CONTROL** (CLASSROOM TEACHING)	**10**
	Definition of pneumatic system, advantages, limitations, applications, Choice of working medium. Characteristic of compressed air. Structure of Pneumatic control System, fluid conditioners and FRL unit. **PNEUMATIC ACTUATORS:** Linear cylinder - types, conventional type of cylinder r-working,end position cushioning, seals, mounting arrangements- applications. Rod - less cylinders types, working, advantages, rotary cylinders- types construction and application, symbols.	

	COMPRESSED AIR: Production of compressed air- preparation of compressed air-driers, filters, regulators, lubricators, distribution of compressed air piping layout.	
UNIT-5	**PNEUMATIC CONTROL VALVES** (ONLINE TEACHING)	**12**
	DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve, quick exhaust valve, time delay valve, shuttle valve, twin pressure valve, symbols. simple pneumatic control: direct and indirect actuation pneumatic cylinders, speed control of cylinders - supply air throttling and exhaust air throttling and exhaust air throttling. **SIGNAL PROCESSING ELEMENTS:** Use of Logic gates - OR and AND gates in pneumatic applications. Practical Examples involving the use of logic gates, Pressure dependant controls- types - construction - practical applications, Time dependent controls principle. Construction, practical applications. **ELECTRO- PNEUMATIC CONTROL:** Principles - signal input and output, pilot assisted solenoid control of directional control valves, relay and contactors. Control circuitry for simple signal cylinder application.	

TEXT BOOKS:

1. **"Fluid Power with Applications",** Anthony Esposito**,** Sixth edition, Pearson Education, Inc, 2000.
2. **'Pneumatics and Hydraulics',** Andrew Parr, Jaico Publilishing Co.

REFERENCE BOOKS:

1. **'Oil Hydraulic systems', Principles and Maintenance** S. R. Majumdar, Tata McGraw Hill Publishing Company Ltd. - 2001
2. **'Industrial Hydraulics',Pippenger, Hicks"** McGraw Hill, New York
3. **'Hydraulic & Pneumatic Power for Production'**, Harry L. Stewart
4. **'Pneumatic Systems',** S. R. Majumdar, Tata McGraw Hill Publish 1995
5. **'Power Hydraulics'** Michael J Pinches & John G Ashby, Prentice Hall.

COURSE OUTCOME (CO): After completion of the course, students will be able to:
CO1: Understand the basics of hydraulic systems and pumps with simple numerical.
CO2: Identify symbols and notations associated with hydraulics components. Also understand the concept of actuators and motors.
CO3: Apply the basics of hydraulic system to design hydraulic circuits.
CO4: Understand the basics of Pneumatic systems and also learn about the pneumatic actuators with production of compressed air.
CO5: Identify symbols associated with pneumatic control valves and apply to signal processing elements in multidisciplinary systems like electro pneumatic controls in automation.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	0	0	2	1	2	0	0	0	0	2
CO2	3	2	2	0	1	1	0	0	0	0	0	2
CO3	3	3	3	2	1	1	1	0	0	0	0	2
CO4	3	2	2	2	2	1	2	0	0	0	0	2
CO5	3	3	3	1	3	1	1	0	0	0	0	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2017-2018 ACADEMIC YEAR: 2020-21
SEMESTER : SEVENTH

COURSE TITLE: RAPID PROTOTYPING (PROFESSIONAL ELECTIVE - 5)		
Sub. Code: ME731	**No of Credits :3 L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03 Total Number of Lecture hours:39**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Manufacturing process**	

COURSE OBJECTIVES:

1. Describe the manufacturing techniques of rapid prototyping process.
2. Successfully apply the following techniques in rapid prototyping process.
3. Analyze the different rapid tooling methods and its uses
4. Evaluate & optimization of different rapid manufacturing processes
5. Geared towards product design, prototyping, advancements and attractive applications

#	CONTENTS	Hrs
UNIT-1	**INTRODUCTION** (CLASS ROOM TEACHING)	**07**
	Additive Manufacturing, The Additive Manufacturing process, Uses, Time compression Engineering(TCE), Benefits of Additive Manufacturing, Rapid Prototyping, Origins of Rapid Prototyping, Rapid Prototyping Cycle, Rapid Prototyping Processes and Future of RP	
UNIT-2	**CLASSIFICATION OF RP SYSTEMS** (CLASS ROOM TEACHING)	**07**
	Classification of RP systems based upon the materials, Stereolithography: apparatus, Operation, process parameters, Applications of stereolithography parts, Advantages and Disadvantages, Solid ground Curing, Selective laser sintering: History, Mechanism, Materials of SLS, Data preparation for SLS, process parameters, Advantages and Disadvantages, Applications and Future of SLS**.**	
UNIT-3	**FUSED DEPOSITION MODELLING** (CLASS ROOM TEACHING)	**07**
	History, Principle, Machine Details, Process Parameters, Path Generation, Advantages and Disadvantages and Applications. **Laminated Object Manufacturing** (LOM): Principle of operation, LOM Materials, Process details, Techniques used in LOM, Applications and Typical uses, Advantages and Disadvantages, **Concept Modellers**: Introduction ,Thermal ink jet printer, Multi Jet Modelling, 3-D printers, Genesis Xs Printer HP System Object Quadra systems.	
UNIT-4	**RAPID TOOLING** (ONLINE TEACHING)	**09**
	Indirect tooling, silicon rubber tooling, Aluminium filled epoxy tooling, spray metal tooling, cast kirksite, 3Q keltool, Direct rapid tooling, Direct AIM (ACES Injection Moulding) Quick cast process, Copper polyamide, DMLS, ProMetal, Sand casting tooling, **Software for RP:** STL file, STL file Resolution, Solid View, Magics, Mimics, Mimics Z, Magics Communicator, **Process Optimization**: Factors influencing accuracy, Errors due to Tessellation: Errors due to slicing, Part building and part finishing.	
UNIT-5	**APPLICATIONS OF RAPID PROTOTYPING** (BLENDED TEACHING)	**09**
	Rapid Prototyping in Medical Field: Introduction, Prostheses and Implants, Surgical planning and scientific applications, Biologically active Implants and Tissue Engineering. RP medical materials**. Rapid Prototyping in Automotive Industry**: key benefits of Automotive Rapid Prototyping, Materials used in Automotive Prototypes, Examples of Automotive Rapid Prototypes**. Rapid Prototyping in Aeronautical Industry, Marine**	

	Applications, Industrial Prototyping, Industrial Rapid Prototypes: Examples, Benefits, and Materials used, Industrial prototyping services and Industrial Applications.	

TEXT BOOKS:

1. Stereolithography and other RP & M Technologies, Paul F, Jacob:SME,NY 1996
2. Rapid Manufacturing, Flham D.T & Dinjoy S S Verlog London 2001
3. Rapid Prototyping and Tooling, Hari prasad and K S Badarinarayan

REFERENCES:

1. Rapid Prototyping, Terry Wohler's Report 2000 " Wohler's " Association 2000
2. Rapid Prototyping Materials, Gurumurthy, IISc Bangalore
3. Rapid Automated, Lament Wood, Indus Press, New york

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Describe the fundamentals of Rapid Prototyping technology and classification of RP techniques to prepare
prototypes for a different product.

CO2: RP techniques such as SLA, SLS, FDM, SGC, and LOM based on their applicability, materials used and advantages.

CO3: Specifically designed concept modelers can adopt to create various models quickly and inexpensively.

CO4: Apply rapid tooling technique for the different specified product easily.

CO5: Create RP models using different software tools. Analyze advanced RP techniques for their suitability and merits.

MAPPING OF COs WITH POs												
COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	2	1	1	1	1	2	1	1
CO2	3	3	2	3	1	1	1	2	1	1	1	2
CO3	3	3	3	2	2	1	1	1	2	1	1	1
CO4	3	3	3	1	2	1	1	1	1	2	1	2
CO5	3	3	2	2	1	1	1	1	2	1	1	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2017-18 ACADEMIC YEAR: 2020-21
SEMESTER : SEVENTH

COURSE TITLE : INTERNAL COMBUSTION ENGINES (PROFESSIONAL ELECTIVE - 5)		
Sub Code: ME732	**No of Credits : L-T-P-SS 03:00:00:00 =03**	**No. of lecture hours/week : 03 Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 100**
Pre-requisites	**Basic and Applied, Thermodynamics**	

COURSE OBJECTIVES:

1. To understand the basic principle of thermodynamic process
2. To understand the basic components and structure of IC engines (both SI and CI engines), process parameters.
3. Understanding the performance of the engine, combustion and exhaust parameters.

UNIT NO.	CONTENTS	Hrs.
1	**CARBURETION** (BLENDED MODE)	**07**
	Introduction, Definition, factors affecting carburetion, air-fuel mixture, mixture requirement, principle of carburetion, simple carburettor, calculation of air-fuel ratio, essential parts of a carburettor, compensating devices, additional systems in modern carburettors, types of carburettors, automobile carburettors, altitude compensation, Numericals.	
2	**INJECTION SYSTEMS** (CLASSROOM MODE)	**06**
	Introduction, Functional requirements, Classification, Fuel feed pump, Injection pump, Injection pump governor, Mechanical and pneumatic governor, Fuel injector, nozzle, Injection in SI engine, Numerical problems, Gasoline injection, Electronic fuel injection system, Multipoint fuel injection system, Functional divisions of MPFI system, Electronic control system, Injection timing, Group gasoline and electronic diesel injection system, Injection control.	
3	**COMBUSTION AND COMBUSTION CHAMBERS** (CLASSROOM MODE)	**07**
	Introduction, homogeneous and heterogeneous mixture, combustion and its stages in SI and CI engine, flame front propagation, factors influencing the flame speed, rate of pressure rise, abnormal combustion, factors affecting the delay period, adiabatic flame temperature, phenomenon of knock in SI and CI engine, effect of engine variable in knock, combustion chambers for SI and CI engine, combustion and its stage in CI engine, comparison of knock in SI and CI engine.	
4	**MEASUREMENT AND TESTING OF PERFORMANCE PARAMETERS** (CLASSROOM MODE)	**10**
	Introduction, measurement of friction power, indicated power, brake power, fuel and air consumption, speed, exhaust and coolant temperature, emission, noise and combustion parameters; engine efficiencies, performance characteristics, factors affecting performance, methods of improving engine performance, heat balance, performance maps, analytical method of performance estimation, Numericals.	
5	**NON CONVENTIONAL ENGINES** (ONLINE MODE)	**09**
	Introduction, Construction, working principle and design of CRDI engine, dual fuel and multi-fuel engine, free piston engine, Gasoline Direct Injection Engine, HCCI engine, Lean burn engine, Stirling engine, Stratified charge engine, VCR engine and Wankel engine, Hybrid electric vehicle (HEV), Introduction to Electric Vehicle Propulsion Systems, Motors and Controls for Electric Vehicles Applications,	

	Storage technologies for EV, Battery pack and battery management system, Solar powered EVs.	

TEXT BOOKS

1. Internal Combustion Engines, V. Ganesan, Tata Mc-Graw Hill Publications,4 Edition, 2012.

2. Internal Combustion Engines, M. L. Mathur and R. P. Sharma, Dhanpat Rai Publications, 2014.

REFERENCE BOOKS

1. **Internal Combustion Engine Fundamentals**, John B. Heywood, Mc-GrawHill Education India Limited, 2011.

2. Engineering Fundamentals of the Internal Combustion Engines, WillardW , Pulkrabek. Pearson Education, 2 Edition, 2015.

3. A Text Book of Internal Combustion Engines, R.K. Rajput, Laxmi Publishers, 2007.

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Describe the carburetion and working principle of different type of carburettor.

CO2: Explain the fuel injection systems in IC engines.

CO3: Describe the combustion process and select suitable combustion chambers for IC engines.

CO4: Evaluate the performance parameters and characteristics of IC engines.

CO5: Differentiate and selection of non-conventional engines in the context of modern developments.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	0	2	0	0	0	0	0	0	2
CO2	3	3	2	0	2	0	2	0	0	0	0	2
CO3	3	3	2	0	2	0	0	0	0	0	0	2
CO4	3	3	3	3	3	0	0	0	0	2	0	2
CO5	3	3	2	1	3	3	3	0	0	2	0	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2017-18 ACADEMIC YEAR: 2020-21
SEMESTER : SEVENTH

COURSE TITLE : ENGINEERING ECONOMICS (PROFESSIONAL ELECTIVE - 5)		
Sub Code: ME733	**No of Credits =03** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 100**
Pre-requisites	**Engineering mathematics**	

COURSE OBJECTIVES:
1. Helping decision making
2. Calculation of interest
3. Arriving at break-even point
4. Feasibility study from economic point of view
5. Preparation of budget
6. Understanding financial statements
7. Arriving at the product cost.

UNIT	CONTENTS	Hrs.
UNIT-1	**INTRODUCTION** (CLASS ROOM TEACHING)	**07**
	Elements of engineering economics, engineering decision- makers, engineering and economics, problem solving and decision making, intuition and analysis, tactics and strategy. Engineering economic decision, maze. Law of demand and supply, law of returns, interest and interest factors: interest rate, simple interest, compound interest, cash - flow diagrams, personal loans and EMI payment, exercises and discussion.	
UNIT-2	**PRESENT-WORTH COMPARISONS** (CLASS ROOM TEACHING)	**08**
	Conditions for present worth comparisons, basic present worth comparisons, present-worth equivalence, net present-worth, assets with unequal lives, infinite lives, future-worth comparison, pay-back comparison, exercises, discussions and problems.	
UNIT-3	**RATE-OF-RETURN CALCULATIONS AND DEPRECIATION** **(**CLASSROOM TEACHING)	**07**
	Rate of return, minimum acceptable rate of return, IRR, IRR misconceptions, cost of capital concepts. Causes of depreciation, basic methods of computing depreciation charges, tax concepts, and corporate income tax.	
UNIT-4	**INTRODUCTION, SCOPE OF FINANCE, FINANCE FUNCTIONS** (CLASS ROOM TEACHING)	**08**
	Statements of financial information: introduction, source of financial information, financial statements, balance sheet, profit and loss account, relation between balance sheet and profit and loss account. Simple Numericals. **FINANCIAL RATIO ANALYSIS**: Introduction, nature of ratio analysis, liquidity ratios, leverage ratios, activity ratios, profitability ratios, evaluation of a firm's earning power. Comparative statements analysis. Simple Numericals.	
UNIT-5	**FINANCIAL AND PROFIT PLANNING** (BLENDED TEACHING)	**09**
	Introduction, financial planning, profit planning, objectives of profit planning, essentials of profit planning, budget administration, type of budgets, preparation of budgets, advantages, problems and dangers of budgeting. Introduction to bench marking of manufacturing operation. **ESTIMATING AND COSTING** Components of costs such as direct material costs, direct labor costs, fixed over-heads,	

	factory cost, administrative overheads, first cost, marginal cost, selling price, estimation for simple components.	

TEXT BOOKS:
1. Engineering Economy, Riggs J.L., McGraw Hill, 2002
2. Engineering Economy, Thuesen H.G. PHI , 2002

REFERENCE BOOKS:
1. Engineering Economy, Tarachand, 2000.
2. Industrial Engineering and Management, OP Khanna, Dhanpat Rai & Sons. 2000
3. Financial Management, Prasanna Chandra, TMH, 2004
4. Financial Management, IM PANDEY, Vikas Publisahing House, 2002

COURSE OUTCOMES: At the end of the course the student will be able to:
CO1: Take the right financial decision.
CO2: Help in calculating the financial factors.
CO3: Arrive at feasibility study of the project.
CO4: Training the students for preparing the budget.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	2	1	1	1	1	2	1	1
CO2	3	3	2	3	1	1	1	2	1	1	1	2
CO3	3	3	3	2	2	1	1	1	2	1	1	1
CO4	3	3	3	1	2	1	1	1	1	2	1	2
CO5	3	3	3	2	2	1	1	1	2	1	1	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2017-18 ACADEMIC YEAR: 2020-21
SEMESTER : SEVENTH

COURSE TITLE : COMPUTER AIDED MODELING AND ANALYSIS LABORATORY		
Sub Code: MEL74	**No of Credits =02 L-T-P-SS::0:2:2:0**	**No. of practical hours/week: 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 50**
Pre-requisites	**Engineering mathematics, MOM, DME**	

COURSE OBJECTIVES:

1. To be able to understand and handle design problems in systematic manner
2. To gain practical experience in 2D drafting and 3D modeling software systems.
3. To be able to apply CAD in real life applications.
4. 4.To be able to understand meaning and Usefulness of FEM
5. To be able to understand Various software used to solve the practical problems

#	Contents	Hrs
UNIT-1	**STUDY OF A FEA PACKAGE AND MODELING STRESS ANALYSIS OF**	**13**
	a. Bars of constant cross section area, tapered cross section area and stepped bar b. Trusses – (Minimum 2 exercises) c. Beams – Simply supported, cantilever, beams with UDL, beams with varying load etc (Minimum 6 exercises) d. Includes Theoretical problems and Introduction to meshing	
UNIT-2	**STRESS ANALYSIS OF**	**13**
	a) Stress analysis of a rectangular plate with a circular hole b) Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions(Minimum 4 exercises) c) Dynamic Analysis 1) Fixed – fixed beam for natural frequency determination 2) Bar subjected to forcing function 3) Fixed – fixed beam subjected to forcing function	

REFERENCE BOOKS:

1. A first course in the Finite element method, Daryl L Logan, Thomason, 3rd Ed.
2. Fundaments of FEM, Hutton – McGraw Hill, 2004
3. Finite Element Analysis, George R. Buchanan, Schaum Series.

COURSE OUTCOMES: On completion of the course, student should be able to:
CO1: Do 3D/2D Modelling and assign the material properties of the models.
CO2: Do proper meshing of the modelled component with different meshing techniques, mesh size control and mesh quality check.
CO3: Assign the required boundary condition, loading condition, types of loading and solve.
CO4: To analyse and evaluate the results obtained after analysis.

MAPPING OF COs WITH Pos												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	2	2	3	3	2	3	3	0	2
CO2	2	3	3	2	2	1	3	2	3	3	0	2
CO3	3	3	3	2	3	2	3	1	3	2	0	2
CO4	3	3	2	2	3	2	3	1	2	2	0	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

SCHEME OF EXAMINATION (SEE)					
Sl. No.	**Particulars**	**Max. Marks**	**Break Up of Max. Marks**		
			Write Up	**Conduction of experiment / Modelling Analysis**	**Expected Out Putt-Results (Different displacement, BM, Stress, Strain results. Etc. and Plotting deformation diagram, SFD,BMD, Graph if it's required)**
1	**Unit-1: Minor Experiment** (Any ONE from the list of experiments and it is purely individual Experiment) Q1	**20**	05	05	10
2	**Unit-2: Major Experiment** (Any ONE **Experiment** from the list of experiments and it is a Group Experiment) Q2	**20**	05	5	10
3	Viva Voce	**10**	--	--	--
TOTAL MARKS		**50**			

ADMISSION YEAR : 2017-18 ACADEMIC YEAR: 2020-21
SEMESTER : SEVENTH

COURSE TITLE : PROJECT WORK PHASE- I		
Sub Code: MEP75	**No of Credits =0** **L-T-P-SS:: 0:0:0:0**	**No. of contact hours/week : 02**
Exam Duration : NA		**Exam Marks : NA**

Course objectives:
1. To provide an amicable atmosphere for students to plan
2. To test their learned theory knowledge in an actual working situation
3. To discover the value of work and relish rewards of accomplishment
4. To ensure a professional preparation to the liberal educational goals.

STAGES FOR PROJECT WORK	
Step 1	Formulation of the problem
Step 2	Exhaustive literature survey
Step 3	Methodology
Step 4	Time estimation for completing the project

The Project proposal shall be submitted within 3 weeks from the start of the semester in the prescribed standard format (04 copies) to the HOD, after the certification of the concerned guide and HOD.
Minimum number of students per batch: 02 Maximum number of students per batch: 04
CIE Evaluation: Two seminars shall be conducted at the end of 6 and 10 week of the semester.

COURSE OUTCOMES: On completion of the course, student should be able to:
CO1: Literature review on par with international journal standards
CO2: Literature gap determination and definition of the problem
CO3: Scientific Design / Numerical Analysis / Analytical model and interpret them
CO4: Apply tools / techniques for problem solving and prepare project work

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	2	1	1	1	1	1	1	1
CO2	3	3	2	1	2	1	1	1	1	2	1	1
CO3	3	3	2	1	2	1	1	1	1	2	1	1
CO4	3	3	3	1	2	1	1	1	1	2	1	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

SCHEME OF EVALUATION (SEE)	
Sl. No.	**Particulars**
1	Formulation of the problem
2	Relevance of the subject in the present context
3	Literature Survey
4	Problem formulation
5	Oral presentation

GUIDELINES FOR PREPARING PROJECT REPORT

1. Project reports should be typed neatly only on one side of the paper with 1.5 or double line spacing on an A4 size bond paper (210 x 297 mm).
2. **The margins should be:** Left – 1.25″, Right – 1″, Top and Bottom – 0.75″.
3. The total number of reports to be prepared are
   i) A copy to the department library
   ii) A copy to the concerned guide(s)
   iii) Two copies to the sponsoring agency
   iv) Candidate's copy.
4. Before taking the final printout, the approval of the **concerned guide(s) is mandatory** with suggested corrections, if any, to be incorporated.
5. For making copies dry tone Xerox is suggested. Every copy of the report must contain Inner title page (White) Outer title page with a plastic cover Certificate in the format enclosed both from the college and the organization where the project is carried out.
6. An **abstract (synopsis)** not exceeding 100 words, indicating salient features of the work. (NB: four copies of the abstract are to be submitted to the Department on the date of submission separately)
7. The organization of the report should be as follows
   i) Inner title page
   ii) Abstract or Synopsis
   iii) Acknowledgments
   iv) Table of Contents
   v) List of table & figures (optional)
   vi) Usually numbered in roman
   vii) Chapters (to be numbered in Arabic) containing Introduction-, which usually specifies the scope of work and its importance and relation to previous work and the present developments, Main body of the report divided appropriately into chapters, sections and subsections.
   viii) The chapters, sections and subsections may be numbered in the decimal form for e.g. Chapter 2, sections as 2.1, 2.2 etc., and subsections as 2.2.3, 2.5.1 etc.
   ix) The chapter must be left or right justified (font size 16). Followed by the title of chapter centered (font size 18), section/subsection numbers along with their headings must be left justified with section number and its heading in font size 16 and subsection and its heading in font size 14. The body or the text of the report should have font size 12.
   x) The figures and tables must be numbered chapter wise for e.g.: Fig. 2.1 Block diagram of a serial binary adder, Table 3.1 Primitive flow table, etc.
   xi) The last chapter should contain the summary of the work carried, contributions if any, their utility along with the scope for further work.
   xii) **Reference OR Bibliography:** The references should be numbered serially in the order of their occurrence in the text and their numbers should be indicated within square brackets for e.g. [3]. The section on references should list them in serial order in the following format.

   For textbooks – A.V. Oppenheim and R.W. Schafer, Digital Signal Processing, Englewood, N.J., Prentice Hall, 3 Edition, 1975.

   For papers – Devid, Insulation design to combat pollution problem, Proc of IEEE, PAS, Vol 71, Aug 1981, pp 1901-1907.

8. Only SI units are to be used in the report. Important equations must be numbered in decimal form for e.g.

$$V = IZ \ldots\ldots\ldots. (3.2)$$

All equation numbers should be right justified.

9. The project report should be brief and include descriptions of work carried out by others only to the minimum extent necessary. Verbatim reproduction of material available elsewhere should be strictly avoided. Where short excerpts from published work are desired to be included, they should be within quotation marks appropriately referenced.

   Proper attention is to be paid not only to the technical contents but also to the organization of the report and clarity of the expression. Due care should be taken to avoid spelling and typing errors. The student should note that report-write-up forms the important component in the overall evaluation of the project
10. Hardware projects must include: the component layout, complete circuit with the component list containing the name of the component, numbers used, etc. and the main component data sheets as Appendix.
11. At the time of report submissions, the students must hand over a copy of these details to the project coordinator and see that they are entered in proper registers maintained in the department.
12. Software projects must include a virus free disc, containing the software developed by them along with the read me file. Read me file should contain the details of the variables used, salient features of the software and procedure of using them: compiling procedure, details of the computer hardware/software requirements to run the same, etc. If the developed software uses any public domain software downloaded from some site, then the address of the site along with the module name etc. must be included on a separate sheet. It must be properly acknowledged in the acknowledgments.
13. Sponsored Projects must also satisfy the above requirements along with statement of accounts, bills for the same dully attested by the concerned guides to process further, They must also produce NOC from the concerned guide before taking the internal viva examination.
14. The reports submitted to the department/guide(s) must be hard bounded, with a plastic covering.
15. Separator sheets, used if any, between chapters, should be of thin paper

COLOUR OF THE OUTER COVER/FRONT PAGE OF UG DISSERTATION / PROJECT REPORT - SKY BLUE

Dr. AMBEDKAR INSTITUTE OF TECHNOLOGY

(An autonomous institution, Aided by Govt. of Karnataka, Affiliated to VTU)
BDA Outer Ring Road, Near Jnana Bharathi Campus, Bengaluru - 560056

Department of Mechanical Engineering

CERTIFICATE

Certified that the project work - Phase I (Seventh Semester) entitled……………………… is carried out by the following bonafide students of Mechanical Engineering in partial fulfilment for the award of Bachelor of Engineering, B. E (Mechanical) at **Dr. Ambedkar Institute of Technology, Bangalore,** during the academic year .... **.**

Sl. No	U S N (ascending order)	Name of Student

It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the project report.

The project report has been approved satisfying the academic requirements prescribed for the said Degree.

Guide	**Internal Examiner**	**HOD**

ADMISSION YEAR : 2017-18 ACADEMIC YEAR: 2020-21
SEMESTER : EIGHTH

COURSE TITLE : COMPUTER INTEGRATED MANUFACTURING (PROFESSIONAL ELECTIVE - 6)		
Sub Code: ME811	**No of Credits =03 L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 100**
Pre-requisites	**Manufacturing process I and II, CAD/CAM**	

Course Objectives:

1. To impart knowledge of CIM and Automation and different concepts of automation by developing mathematical models.
2. To expose students to automated flow lines, assembly lines, Line Balancing Techniques, and Flexible Manufacturing Systems.
3. To expose students to computer aided process planning, material requirement planning, capacity planning etc.
4. To introduce the students to concepts of Additive Manufacturing, Internet of Things, and Industry 4.0 leading to Smart Factory.

UNIT	CONTENT	Hrs.
UNIT 1	**Introduction to CIM and Automation:** (BLENDED TEACHING) Automation in Production Systems, automated manufacturing systems- types of automation, reasons for automating, Computer Integrated Manufacturing, computerized elements of a CIM system, CAD/CAM and CIM. Mathematical models and matrices: production rate, production capacity, utilization and availability, manufacturing lead time, work-in process, Numerical problems and automation strategies.	**08**
UNIT 2	**Automated Production Lines and Assembly Systems:** (BLENDED TEACHING) Fundamentals, system configurations, applications, automated flow lines, buffer storage, control of production line, analysis of transfer lines, analysis of flow lines without storage, partial automation, analysis of automated flow lines with Storage buffer, fundamentals of automated assembly systems, numerical problems.	**08**
UNIT 3	**Flexible Manufacturing Systems:** (BLENDED TEACHING) Fundamentals of Group Technology and Flexible Manufacturing Systems, types of FMS, FMS components, Material handling and storage system, applications, benefits, computer control systems, FMS planning and design issues, Automated Storage and Retrieval Systems, AS/RS and Automatic parts identification systems and data capture. **Line Balancing:** Line balancing algorithms, methods of line balancing, numerical problems on largest candidate rule, Kilbridge and Wester method, and Ranked Positional Weights method.	**08**
UNIT 4	**Computerized Manufacture Planning and Control System:** (ONLINE TEACHING) Computer Aided Process Planning, Retrieval and Generative Systems, benefits of CAPP, Production Planning and Control Systems, typical activities of PPC System, computer integrated production management system, Material Requirement Planning, inputs to MRP system, working of MRP, outputs and	**08**

	benefits, Capacity Planning, Computer Aided Quality Control, Shop floor control. **Automated Assembly Systems:** Design for automated assembly systems, types of automated assembly system, Parts feeding devices-elements of parts delivery system-hopper, part feeder, Selectors, feedback, escapement and placement. **Automated Guided Vehicle System**: Introduction, types, Vehicle guidance and routing, System management.	
UNIT 5	**Additive Manufacturing Systems:** (ONLINE TEACHING) Basic principles of additive manufacturing, slicing CAD models for AM, advantages and limitations of AM technologies, Additive manufacturing processes: Photo polymerization, material jetting, binder jetting, material extrusion, Powder bed sintering techniques, sheet lamination, direct energy deposition techniques, applications of AM. Recent trends in manufacturing, Hybrid manufacturing. **Future of Automated Factory:** Industry 4.0, functions, applications and benefits. Components of Industry 4.0, Internet of Things (IOT), IOT applications in manufacturing, Big-Data and Cloud Computing for IOT, IOT for smart manufacturing, influence of IOT on predictive maintenance, industrial automation, supply chain optimization, supply-chain & logistics, cyber-physical manufacturing systems.	**07**

TEXT BOOKS:

1. Automation, Production system & Computer Integrated manufacturing, M. P. Groover" 4th Edition, 2015, Pearson Learning.
2. Principles of Computer Integrated Manufacturing, S. Kant Vajpayee, Prentice Hall India.
3. CAD/CAM/CIM, Dr P Radhakrishnan, 3rd edition, New Age International Publishers, New Delhi.

REFERENCE BOOKS

1. "CAD/CAM" by Ibrahim Zeid, Tata McGraw Hill.
2. "Principles of Computer Integrated Manufacturing", S.Kant Vajpayee, 1999, Prentice Hall of India, New Delhi.
3. "Work Systems and the Methods, Measurement and Management of Work", Groover M. P, Pearson/Prentice Hall, Upper Saddle River, NJ, 2007.
4. "Computer Automation in Manufacturing", Boucher, T. O., Chapman & Hall, London, UK, 1996.
5. "Introduction to Robotics: Mechanics and Control", Craig, J. J., 2nd Ed., Addison-Wesley Publishing Company, Readong, MA, 1989.
6. Internet of Things (IoT): Digitize or Die: Transform your organization. Embrace the digital evolution. Rise above the competition, by Nicolas Windpassinger, Amazon.
7. "Internet of Things: A Hands-on Approach", by Arshdeep Bahga and Vijay Madisetti (Universities Press)
8. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 2nd Ed. (2015), Ian Gibson, David W. Rosen, Brent Stucker
9. "Understanding Additive Manufacturing", Andreas Gebhardt, Hanser Publishers, 2011
10. Industry 4.0: The Industrial Internet of Things, A press, 2017, by Alasdair Gilchrist.

COURSE OUTCOMES (COS): On completion of this course you should be able to:

CO1: Able to define Automation, CIM, CAD, CAM and explain the differences between these concepts.

CO2: Explain the basics of automated manufacturing industries through mathematical models and analyse different types of automated flow lines.

CO3: Analyse the FMS, GT, AS/RS and automated flow lines to reduce down time and enhance productivity.

CO4: Design and development of various types of Computerized Manufacture Planning and Control System, materials handling systems, CAPP, MRP, capacity planning, shop floor control and CAQC.

CO5: Visualize and appreciate the modern trends in Manufacturing like additive manufacturing, Industry 4.0 and applications of Internet of Things leading to Smart Manufacturing.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	2	1	1	1	1	2	1	1
CO2	3	3	2	3	1	1	1	2	1	3	1	2
CO3	3	3	3	2	2	1	1	1	2	3	1	1
CO4	3	3	3	1	2	1	1	1	1	2	1	2
CO5	3	3	3	1	2	1	1	1	1	2	1	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2017-18 ACADEMIC YEAR: 2020-21
SEMESTER : EIGHTH

COURSE TITLE : COMPUTATIONAL FLUID DYNAMICS (PROFESSIONAL ELECTIVE - 6)		
Sub Code: ME812	**No of Credits : L-T-P-SS 03:00:00:00 =03**	**No. of lecture hours/week : 03 Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 100**
Pre-requisites	**Fluid dynamics, Mathematics**	

COURSE OBJECTIVES:

1. To understand the fundamentals of CFD and fluid flow equations in conservation forms.
2. To understand the various methods of solving linear algebraic equations.
3. To know the discretization methods and understand how it can be used in heat conduction problems.
4. To know the equations related to convection and diffusion and understand the methods to solve these equations.
5. To understand the Navier Stokes equations and turbulent modeling.

	CONTENTS	Hrs
UNIT-1	**INTRODUCTION TO COMPUTATIONAL FLUID DYNAMICS** (BLENDED MODE)	**07**
	Computational Fluid Dynamics: What, When, and Why?, CFD Applications, Experimental investigations, theoretical calculations, advantages and disadvantages of theoretical calculations, Fundamental principles of conservation, Reynolds transport theorem, Conservation of mass, Conservation of momentum, Conservation of Energy equations, Navier-Stokes equation, Time-average equations for turbulent flow, the turbulent kinetic energy equation, the general differential equations, Nature of coordinates : Independent variables, choice of coordinates, one way and two way coordinates.	
UNIT-2	**SOLUTION OF SYSTEMS OF LINEAR ALGEBRAIC EQUATIONS** (CLASSROOM MODE)	**08**
	Criteria for unique solution, infinite number of solutions and no solution, Solution techniques for systems of linear algebraic equations: Elimination, Iteration and Gradient Search method, Elimination method: Forward elimination and backward substitution, Assessment of number of computations, L-U decomposition technique, Tridiagonal matrix algorithm (TDMA): Thomas algorithm Iteration methods: Jacobi’s method and Gauss Siedel method, Generalized analysis of the iterative methods, Sufficient condition for convergence, Rate of convergence, Scarborough criteria of sufficient condition for convergence in Gauss Siedel Method, Illustrative examples of Jacobi’s method and Gauss Siedel method.	
UNIT-3	**DISCRETISATION METHODS AND HEAT CONDUCTION** (CLASSROOM MODE)	**08**
	The Discretization concept, The structure of Discretization equation, Methods of deriving the Discretization equation: Taylor series formulation, variation formulation, method of Weighted residuals, Control Volume formulations. Illustrative examples, Four basic rules, Numerical problems. Heat conduction: Steady one dimensional Conduction: The basic Equation, The grid Spacing, The interface conductivity, Non linearity, Source term Linearization, Boundary conditions, Unsteady one dimensional Conduction: the general Discretization equation,	

	Explicit, Crank Nicolson and fully implicit schemes, Two dimensional and three dimensional situation, Over relaxation and Under relaxation Methods. Problems.	
UNIT-4	**CONVECTION AND DIFFUSION** (CLASSROOM MODE)	**08**
	Steady one dimensional Convection and diffusion, the primary derivation, the upwind scheme, the exact solution, The Exponential scheme, The Hybrid scheme, The power law scheme, consequences of various scheme, Discretization equation for Two dimension, details of derivation, final Discretization equation, Discretization equation for Three dimension, one way space coordinates, outflow boundary conditions, False diffusion: common and proper view of False diffusion.	
UNIT-5	**NAVIER STOKES EQUATIONS AND TURBULENT MODELLING** (ONLINE MODE)	**08**
	Discretization of the Momentum Equation: Stream Function-Vorticity approach and Primitive variable approach, Staggered grid and Collocated grid, SIMPLE Algorithm, SIMPLER Algorithm, Important features of turbulent flow, Vorticity transport equation, Statistical representation of turbulent flows: Homogeneous turbulence and isotropic turbulence, General Properties of turbulent quantities, Reynolds average Navier stokes (RANS) equation, Closure problem in turbulence: Necessity of turbulence modeling, Different types of turbulence model: Eddy viscosity 2 models, Mixing length model, Turbulent kinetic energy and dissipation, The κ-ε model, Advantages and disadvantages of κ -ε model.	

TEXT BOOKS:

1. **Computational Fluid Dynamics: The Basics with Applications,** John D. Anderson, Jr., McGraw-Hill International Editions, 1995.
2. **Computational Fluid Flow and Heat Transfer,** K. Muralidhar and T.Sundararajan (Editors), 2nd Edition, Narosa Publishing House, 2003.
3. **Introduction to Computational Fluid Dynamics:** H.K. Versteeg and W. Malalasekera, Pearson Education Limited, 2nd Edition, 2007.

REFERENCE BOOKS:

1. **Computational Fluid Methods for Fluid Dynamics**, J.H. Ferziger and M. Peric, Springer (India) Pvt. Ltd., 3rd Edition, 2002.
2. **Introduction to Computational Fluid Dynamics**, Pradip Niyogi, S.K. Chakrabartty, M.K. Laha, Pearson Education, 2011.
3. **Numerical Heat Transfer and Fluid Flow**, Suhas V. Patankar, Hemisphere Publishing Corporation, 1980.

e-LEARNING RESOURCES

Videos, Lecture notes: http://www.nptel.ac.in

COURSE OUTCOME (CO)

After completion of the course, students will be able to:

CO1: Understand the fundamental concepts of computational fluid dynamics and explain Reynolds transport theorem.

CO2: Demonstrate the different methods of solving a system of linear algebraic equations.

CO3: Understand the concept of Discretization and its methods; Discretize the heat conduction equations and solve numerical problems.

CO4: Derive the one dimensional steady convection and diffusion equation; Discretize these equations using different methods.

CO5: Discretize the momentum equation and understand the various turbulent models.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	1	1	1	1	1	1	1	1
CO2	3	3	2	1	1	1	1	1	1	1	1	1
CO3	3	3	3	1	1	1	1	1	1	1	1	1
CO4	3	3	2	1	1	1	1	1	1	1	1	1
CO5	3	3	3	1	1	1	1	1	1	1	1	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										
3. Each full question shall have maximum of 3 sub-divisions.										

ADMISSION YEAR : 2017-18 ACADEMIC YEAR: 2020-21
SEMESTER : EIGHTH

COURSE TITLE : SMART MATERIALS (PROFESSIONAL ELECTIVE - 6)		
Sub Code: ME813	**No of Credits =03** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 100**
Pre-requisites	**Material science, Composite materials**	

COURSE OBJECTIVES:

1. The aim of this course is to integrate research results with curriculum development for the benefit of the students in physics, materials science and engineering civil and structural engineering, mechanical and aerospace engineering, industrial and systems engineering, as well as electrical and electronic engineering.
2. The fundamentals of smart materials, device and electronics, in particular those related to the development of smart structures and products.
3. The skills, knowledge and motivation in the design, analysis and manufacturing of smart structures and products.

#	CONTENTS	Hrs
UNIT-1	**INTRODUCTION TO SMART MATERIALS (Classroom Teaching)**	**07**
	Characteristics of composites and ceramic materials, Smart materials and their types, dynamics and controls, concepts, Electro-magnetic materials and shape memory alloys-processing and characteristics.	
UNIT-2	**SMART STRUCTURES (Blended Learning)**	**08**
	Types of smart Structures, potential feasibility of smart structures, key elements of smart structures, applications of smart structures. Piezoelectric materials, properties, piezoelectric constitutive relations, poling and coercive field, field strain relation. Hysteresis, creep and strain rate effects, inchworm linear motor.	
UNIT-3	**SENSING AND ACTUATION (Blended Learning)**	**08**
	Principles of electromagnetic, acoustics, chemical and mechanical sensing and actuation, Types of sensors and their applications, signal processing, principals and characterization of sensors.	
UNIT-4	**SHAPE MEMORY ALLOY (Blended Learning)**	**08**
	Experimental Phenomenology, Shape Memory Effect, phase transformation, super elasticity, Tanaka’s constitutive model, SME testing of SMA wires, vibration control through SMA, Testing of super elasticity, Applications Of SMA. **ER AND MR FLUIDS** Mechanisms and properties, fluid composition and behavior, The Bingham plastic and related models, pre-yield response. Post-yield flow applications in clutches, dampers and others.	
UNIT-5	**VIBRATION ABSORBERS and MEMS (Blended Learning)**	**08**
	VIBRATION ABSORBERS: Series and parallel damped vibrations (overview), active vibration absorbers, fiber optics, physical phenomena, characteristics, sensors, fiber optics in crack detection, applications, biomimetics. **MEMS:** Mechanical properties of MEMS materials, scaling of mechanical systems, fundamentals of theory, the intrinsic characteristics of MEMS, miniaturization, microelectronics integration.	

TEXT BOOKS:

1. **‘Analysis and Design’,** A. V. Srinivasan, ‘Smart Structures –Cambridge University Press, New York, 2001, (ISBN : 0521650267)
2. **‘Smart Materials and Structures’,** M V Gandhi and B S Thompson Chapmen & Hall, London, 1992 (ISBN : 0412370107)

REFERENCE BOOKS:

1. **‘Smart Materials and Structures’,** Banks HT, RC Smith, Y Wang, Massow S A, Paris 1996
2. **G P Gibss’Adaptive Structres’,** Clark R L, W R Saunolers, Jhon Wiles and Sons, New York, 1998
3. **An introduction for scientists and Engineers’,**EsicUdd, Optic Sensors :Jhon Wiley & Sons, New York, 1991 (ISBN : 0471830070).

COURSE OUTCOMES: On completion of this COURSE, students should be able to:
CO1: Understand the physical principles underlying the behaviour of smart materials;
CO2: Analyze the properties of smart structures, Piezo electric materials with the applications and select suitable procedure for fabrication.
CO3: Understand the engineering principles in smart sensor, actuator and technologies
CO4: Explain the principle concepts of ER & MR Fluids and shape memory alloys with principles of working.
CO5: Describe the methods of controlling vibration using smart systems and fabrication methods of MEMS. Explain the principle concepts of Biomimetic, Fibre optics and actuation with principles of working.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	2	1	1	1	1	1	2	1
CO2	3	3	2	3	2	1	1	1	1	1	2	1
CO3	3	3	2	3	3	1	1	1	1	1	2	1
CO4	3	3	3	3	2	1	1	1	1	1	2	1
CO5	3	3	3	3	2	1	1	1	1	1	2	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2017-18 ACADEMIC YEAR: 2020-21
SEMESTER : EIGHTH

COURSE TITLE : CONTROL ENGINEERING LABORATORY		
Sub Code: MEL82	**No of Credits =1** **L-T-P-SS::0:2:2:0**	**No. of practical hours/week: 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 50**
Pre-requisites	**Control engineering**	

COURSE OBJECTIVES:

1. To understand the basics of control system.
2. To control the heat flow rate and temperature in a tank.
3. To determine effectiveness of PID controller in heating tanks
4. To analyse the control action on the liquid levels in tanks.
5. To control the speed of DC motor.

#	CONTENTS	Hrs
UNIT-1	Basics and heated tank	6
	1. No control heated tank 2. Bump less transfer heated tank 3. General transfer function 4. Anti-windup heated tank 5. PID standard temperature control of heated tank 6. Cascade temperature control of heated tank.	
UNIT-2	Liquid level control	6
	1. Manual level control 2. PID standard level control in chip tank 3. PID discrete General transfer function 4. Feed forward liquid level control in single tank. 5. Feed forward liquid level control in double tank.	
UNIT-3	Speed control of DC motor	8
	1. Step test 2. Set point weighing 3. Position and step test 4. Speed integral control 5. PI implementation. 6. PID position implementation.	
UNIT-4	**Magnetic levitation**	6
	1. On-off control 2. P- control 3. Transient response 4. PD control for desired pole placement **5.** PD control for desired transient response	

COURSE OUTCOMES: On completion of the course, students should be able to:
CO1: Evaluate thermal control action and effectiveness of PID control.
CO2: Plot the characteristic graphs to analyse of liquid level control.
CO3: Develop motors speed controls as required in industries.
CO4: Evaluate and optimise the magnetic levitation system.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	0	1	1	1	1	2	0	1
CO2	3	3	2	3	0	1	1	2	1	1	0	2
CO3	3	3	3	2	0	1	1	1	2	1	0	1
CO4	3	3	3	1	0	1	1	1	1	2	0	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

SCHEME OF EXAMINATION	
One Question from Unit – 1 or 2	15 Marks (05 Write up +10)
One Question from Unit – 3 or 4	25 Marks (05 Write up +20)
Viva-Voce	10 Marks
Total	**50 Marks**

ADMISSION YEAR :	**2017-18**	**ACADEMIC YEAR: 2020-21**
SEMESTER :	**EIGHTH**	

COURSE TITLE : SEMINAR		
Sub Code: MES83	**No of Credits : 02**	**No. of contact hours/week : 04**
		CIE Marks: 50

COURSE OBJECTIVES:
1. To equip students for making a technical presentation based on a thorough re-search review on any contemporary area of Engineering and Management fields
2. Offering the student an opportunity to interact with faculty and peer group and to build the ability to making independent presentation.

STAGES OF SUBJECT SEMINAR
Identification of seminar topic related to area of interest in the field of advanced mechanical engineering.
Literature survey on the selected topics and collection of research papers.
Final seminar shall be presented during 8 /9 week of the semester in the department before the Departmental Evaluation Committee constituted by HOD.
The seminar marks are to be awarded by the committee.
Students shall submit the seminar report in the prescribed standard format.

COURSE OUTCOMES: On completion of the course, student should be able to:
CO1: Conduct literature survey on a current topic based on peer reviewed literature and identify research gap in the literature
CO2: Develop methodologies to resolve the identified problem(s)
CO3: Develop presentation slides / report arranging the material coherently and discuss the topic with clarity and confidence.
CO4: Summarize the presentation, submit the report and identify scope for further work.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	2	3	3	3	3	3
CO2	3	3	2	3	3	3	2	3	3	3	3	3
CO3	3	3	3	3	3	3	2	3	3	3	3	3
CO4	3	3	2	1	3	3	3	3	3	3	3	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

SCHEME OF EVALUATION				
		MARKS ALLOTED		
PARTICULARS	**MAX MARKS**	**EXAMINER 1**	**EXAMINER 2**	**AVERAGE**
Report	**20**			
Relevance of topic with the programme	**10**			
Oral presentation	**10**			
Viva Voce	**10**			
TOTAL	**50**			

ADMISSION YEAR : 2017-18 ACADEMIC YEAR: 2020-21
SEMESTER : EIGHTH

COURSE TITLE : PROJECT WORK PHASE – II		
Sub Code: MEP84	**No of Credits : 12**	**No. of contact hours/week : 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**

COURSE OBJECTIVES:
1. To provide an opportunity and atmosphere in which students may test theory learned in the classroom in an actual working situation and discover the value of work and the rewards of accomplishment
2. To insure a natural transition to the higher level of professional preparation as a complement to the liberal education goals of the Institution.

STAGES OF PROJECT WORK
Identification of project topic related to area of interest in the field of advanced or current mechanical engineering
Literature survey based on the identified topic
Define / formulate the problem and the methodology
Design and fabricate or analysis based on type of problem
Results, conclusions, scope for further work
References.
Oral presentation of the project at the end of 6^{th} and 10^{th} week of a semester

OUTCOMES: On completion of the course, student should be able to:
CO1: Perform literature review on par with international journal standards.
CO2: Identify literature gap and define the problem.
CO3: Design experiments scientifically / perform numerical analysis / develop analytical models and interpret the results and apply advanced tools / techniques for solving the problem.
CO4: Prepare quality document of project work.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	1	1	3	3	2	3	1
CO2	3	3	2	3	3	1	1	3	3	2	3	2
CO3	3	3	3	3	3	1	1	3	3	2	3	2
CO4	3	3	2	1	3	1	1	2	2	3	3	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

CIE EVALUATION: Two presentations shall be conducted at the end of 6^{th} and 10^{th} week of the semester. The Project Report shall be submitted in the prescribed standard format (04 copies) to the HOD, after the certification of the concerned guide and HOD.

SCHEME OF EVALUATION (CIE)				
		MARKS ALLOTED		
PARTICULARS	**MAX MARKS**	**EXAMINER 1**	**EXAMINER 2**	**AVERAGE**
Relevance of topic with the programme	**10**			
Oral presentation	**30**			
Viva Voce	**10**			
TOTAL	**50**			

SCHEME OF EVALUATION (SEE)		
Sl. No.	**Particulars**	**Max. Marks**
1	Relevance of the subject in the present context	**10**
2	Literature Survey	**10**
3	Problem formulation	**10**
4	Experimental observation / theoretical modelling	**10**
5	Results – Presentation & Discussion	**10**
6	Conclusions and scope for future work	**10**
7	Overall presentation of the Thesis/Oral presentation	**40**
	Total Marks	**100**

GUIDELINES FOR PREPARING PROJECT REPORT

8. Project reports should be typed neatly only on one side of the paper with 1.5 or double line spacing on an A4 size bond paper (210 x 297 mm).
9. **The margins should be:** Left – 1.25″, Right – 1″, Top and Bottom – 0.75″.
10. The total number of reports to be prepared are
    v) A copy to the department library
    vi) A copy to the concerned guide(s)
    vii) Two copies to the sponsoring agency
    viii) Candidate’s copy.
11. Before taking the final printout, the approval of the **concerned guide(s) is mandatory** with suggested corrections, if any, to be incorporated.
12. For making copies dry tone Xerox is suggested. Every copy of the report must contain Inner title page (White) Outer title page with a plastic cover Certificate in the format enclosed both from the college and the organization where the project is carried out.
13. An **abstract (synopsis)** not exceeding 100 words, indicating salient features of the work. (NB: four copies of the abstract are to be submitted to the Department on the date of submission separately)
14. The organization of the report should be as follows
    xiii) Inner title page
    xiv) Abstract or Synopsis
    xv) Acknowledgments
    xvi) Table of Contents
    xvii) List of table & figures (optional)
    xviii) Usually numbered in roman

xix) Chapters (to be numbered in Arabic) containing Introduction-, which usually specifies the scope of work and its importance and relation to previous work and the present developments, Main body of the report divided appropriately into chapters, sections and subsections.

xx) The chapters, sections and subsections may be numbered in the decimal form for e.g. Chapter 2, sections as 2.1, 2.2 etc., and subsections as 2.2.3, 2.5.1 etc.

xxi) The chapter must be left or right justified (font size 16). Followed by the title of chapter centered (font size 18), section/subsection numbers along with their headings must be left justified with section number and its heading in font size 16 and subsection and its heading in font size 14. The body or the text of the report should have font size 12.

xxii) The figures and tables must be numbered chapter wise for e.g.: Fig. 2.1 Block diagram of a serial binary adder, Table 3.1 Primitive flow table, etc.

xxiii) The last chapter should contain the summary of the work carried, contributions if any, their utility along with the scope for further work.

xxiv) **Reference OR Bibliography:** The references should be numbered serially in the order of their occurrence in the text and their numbers should be indicated within square brackets for e.g. [3]. The section on references should list them in serial order in the following format.

For textbooks – A.V. Oppenheim and R.W. Schafer, Digital Signal Processing, Englewood, N.J., Prentice Hall, 3 Edition, 1975.

For papers – Devid, Insulation design to combat pollution problem, Proc of IEEE, PAS, Vol 71, Aug 1981, pp 1901-1907.

9. Only SI units are to be used in the report. Important equations must be numbered in decimal form for e.g.

$$V = IZ \dots\dots\dots (3.2)$$

All equation numbers should be right justified.

16. The project report should be brief and include descriptions of work carried out by others only to the minimum extent necessary. Verbatim reproduction of material available elsewhere should be strictly avoided. Where short excerpts from published work are desired to be included, they should be within quotation marks appropriately referenced.

Proper attention is to be paid not only to the technical contents but also to the organization of the report and clarity of the expression. Due care should be taken to avoid spelling and typing errors. The student should note that report-write-up forms the important component in the overall evaluation of the project

17. Hardware projects must include: the component layout, complete circuit with the component list containing the name of the component, numbers used, etc. and the main component data sheets as Appendix.

18. At the time of report submissions, the students must hand over a copy of these details to the project coordinator and see that they are entered in proper registers maintained in the department.

19. Software projects must include a virus free disc, containing the software developed by them along with the read me file. Read me file should contain the details of the variables used, salient features of the software and procedure of using them: compiling procedure, details of the computer hardware/software requirements to run the same, etc. If the developed software uses any public domain software downloaded from some site, then the address of the site along with the module name etc. must be

included on a separate sheet. It must be properly acknowledged in the acknowledgments.

20. Sponsored Projects must also satisfy the above requirements along with statement of accounts, bills for the same dully attested by the concerned guides to process further, They must also produce NOC from the concerned guide before taking the internal viva examination.
21. The reports submitted to the department/guide(s) must be hard bounded, with a plastic covering.
22. Separator sheets, used if any, between chapters, should be of thin paper

COLOUR OF THE OUTER COVER/FRONT PAGE OF UG DISSERTATION / PROJECT REPORT - SKY BLUE

Dr. AMBEDKAR INSTITUTE OF TECHNOLOGY

(An autonomous institution, Aided by Govt. of Karnataka, Affiliated to VTU)
BDA Outer Ring Road, Near Jnana Bharathi Campus, Bengaluru - 560056

Department of Mechanical Engineering

CERTIFICATE

Certified that the project work - Phase II (Eighth Semester) entitled……………………… is carried out by the following bonafide students of Mechanical Engineering in partial fulfilment for the award of Bachelor of Engineering, B. E (Mechanical) at **Dr. Ambedkar Institute of Technology, Bangalore,** during the academic year .... **.**

Sl. No	**U S N** **(ascending order)**	**Name of Student**

It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the project report.

The project report has been approved satisfying the academic requirements prescribed for the said Degree.

Guide	**HOD**	**Principal**

External Viva:

Sl. No	Name of the examiner	Signature with date
1		
2		

DR AMBEDKAR INSTITUTE OF TECHONOLOGY

DEPARTMENT OF MECHNICAL ENGINEERING

SCHEME AND SYLLABUS

FOR

M.Tech MACHINE DESIGN

YEAR 2016-17

PROGRAM EDUCATIONAL OBJECTIVES

PEO1--Graduates will have knowledge in the discipline of Machine Design with hands on skill in using modern engineering tools to address real world engineering problems and be socially responsible.
PEO2– Graduates shall be successful in their career as analysts and designers of structural components of conventional and advanced materials, participating in a team or individually in an industry, research or academia.
PEO3– Graduates shall be proficient in their communication, presentation and will be prepared to engage in the process of life-long learning through professional development and research.

PROGRAM OUTCOMES

PO No.	Program Outcomes (PO)
PO1	Acquire in-depth knowledge of specific discipline or professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.
PO2	Analyze complex engineering problems critically, apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context
PO3	Think laterally and originally, conceptualize and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.
PO4	Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.
PO5	Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of the limitations.
PO6	Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.
PO7	Demonstrate knowledge and understanding of engineering and management principles and apply the same to one’s own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economic and financial factors.
PO8	Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.
PO9	Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.
PO10	Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.
PO11	Observe and examine critically the outcomes of one’s actions and make corrective

DR AMBEDKAR INSTITUTE OF TECHONOLOGY

M.TECH/ MACHINE DESIGN **CREDIT BASED**

Subject Code	Name of the Subject	I SEMSTER						
		MARKS	CREDITS	L	T	P	S	TOTAL
16MMD11	ADVANCED MECHANICS OF SOLIDS	100	04	4	0	0	0	4
16MMD12	FINITE ELEMENT METHOD	100	04	4	0	0	0	4
16MMD13	ADVANCED DESIGN OF MECHANISM	100	04	4	0	0	0	4
16MMD14	ADVANCED THEORY OF VIBRATIONS	100	04	4	0	0	0	4
16MMD15X	ELECTIVE-I	100	04	4	0	0	0	4
16MMDL16	VIBRATION LAB	100	02	0	0	02	0	2
16MMDS17	TECHNICAL SEMINAR	100	02	0	0	0	02	2
16MMDM18	MINI PROJECT OR INDUSTRIAL VISIT	100	02	0	0	0	02	2
	TOTAL	**800**	**26**	**20**	**00**	**02**	**04**	**26**

ELECTIVE –I

16MMD151 MECHATRONICS SYSTEMS DESIGN

16MMD152 DESIGN FOR MANUFACTURE

16MMD153 AUTOMOBILE SYSTEM DESIGN

Subject Code	Name of the Subject	II SEMSTER						
		MARKS	CREDITS	L	T	P	S	TOTAL
16MMD21	COMPOSITE MATERIAL TECHONOLOGY	100	04	4	0	0	0	4
16MMD22	ADVANCED MACHINE DESIGN	100	04	4	0	0	0	4
16MMD23	EXPERIMENTAL MECHANICS	100	04	4	0	0	0	4
16MMD24	TRIBOLOGY & BEARING DESIGN	100	04	4	0	0	0	4
16MMD25X	ELECTIVE-I	100	04	4	0	0	0	4
16MMDL26	FINITE ELEMENT ANALYSIS LAB	100	02	0	0	02	0	2
RM 27	RESEARCH METHODOLOGY	100	02	0	0	0	02	2
16MMDM28	MINI PROJECT //INDUSTRIAL VISIT/FIELD WORK/TECHNICAL	100	02	02	0	0	0	2
	TOTAL	**800**	**26**	**22**	**00**	**02**	**02**	**26**

ELECTIVE-I

16MMD251 THEORY OF PLASTICITY

16MMD252 ROTOR DYNAMICS

16MMD253 FINITE ELEMENT METHODS FOR HEAT TRANSFER AND FLUID FLOW ANALYSIS

Subject Code	Name of the Subject	III SEMSTER						
		MARKS	CREDITS	L	T	P	S	TOTAL
16MMD31	MIDTERM PRESENTATION ON INTERNSHIP	50	2	0	0	2	0	02
16MMD32	REPORT ON INTERNSHIP	100	13	0	0	13	0	13
16MMD33	EVALUATION AND VIVA-VOCE ON INTERNSHIP	100	05	0	0	05	0	05
16MMD32	PROJECT PHASE-1	50	00	0	0	0	0	PP
	TOTAL	**300**	**20**	**0**	**0**	**20**	**00**	**20**

NOTE: III Semester:

- **Internship**: The student shall undergo internship for 16 weeks.

  Preliminary Report submission and Evaluation after 8th week of Internship to be carried out by the Internal Guide of the college and a senior faculty for 50 marks

  Final report submission and evaluation to be carried out after 16th week of internship by the internal guide of the college and a senior faculty. Report evaluation to be completed within two weeks of submission for 100 marks.

  Viva-Voce on Internship - To be conducted by the Internship Guide (from the college) and the External Guide / Examiner within 2 weeks of Submission with a senior faculty / HOD as chairman for 100 marks

- **Project Phase: I**

  Problem formulation and submission of **synopsis** within 8 weeks from the commencement of 3rd semester, which shall be evaluated for 50 marks by the committee constituted for the purpose by the Head of the Department comprising the guide, senior faculty of the department with HOD as Chairman.

  Literature survey and progress done after 16 weeks shall be evaluated by guide and external examiner with senior faculty / HOD as chairman for 100 marks.

Subject Code	Name of the Subject	IV SEMSTER						
		MARKS	CREDITS	L	T	P	S	TOTAL
16MMD41	FRACTURE MECHANICS	100	04	4	0	0	0	4
16MMD42X	ELECTIVE-I	100	04	4	0	0	0	4
16MMD43	PROJECT PHASE-II	100	02	0	0	0	02	20
16MMD44	PROJECT VIVA- VOCE	200	18	0	0	18	0	
	TOTAL	**500**	**28**	**08**	**00**	**18**	**02**	**28**

ELECTIVE-I

16MMD421 COMPUTATIONAL FLUID DYNAMICS

16MMD422 SMART MATERIALS & STRUCTURES

16MMD423 DESIGN OPTIMIZATION

IV Semester:

- **Project Phase-II -** Internal Evaluation of progress in Project work shall be evaluated after 8 weeks for 100 marks by the committee constituted for the purpose by the Head of the Department comprising the guide and senior faculty of the department with HOD as Chairman.
- **Project Phase-III -** Internal Evaluation of Project Demonstration, which shall be evaluated after 15 weeks for 100 marks by the committee constituted for the purpose by the Head of the Department.
- **Final Evaluation** of Project Work and Viva-voce.
- **Final evaluation** of project to be carried out after 16 weeks from the date of commencement of 4th semester.
- **The Internal Examiner** (the project guide with a teaching experience of at least three years) and External Examiner with HOD as chairman will complete the final evaluation of Project.
- **Internal and External Examiners** shall carry out the evaluation for 100 Marks each and the average of these marks shall be the final marks of the Project Evaluation.
- **Viva – Voce**: The Viva-Voce shall be conducted jointly by Internal Examiner and External Examiner with HOD as chairman for 100 Marks.

ADVANCED MECHANICS OF SOLIDS

Course Code	**:**	**16MMD11**		**CIE Marks**	**:**	**50**
Hrs./Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:

This course aims at a comprehensive study of mechanics of solids. The topics covered are

1. Analysis of stress, strain and stress-strain relations.
2. Solution of plane elasticity problems in rectangular and polar coordinates using analytical methods including thermal loads, body forces and surface tractions
3. Formulation of 3-D boundary value problems
4. Torsion of prismatic bars

Course Content: Chapters/ Units

1. **Introduction:** Definition and notation for forces and stresses. Components of stresses, equations of equilibrium, specification of stress at a point. Principal stresses and Mohr's diagram in 3 dimensions. Boundary conditions, interaction of given surface forces. Strain components, specification of strain at a point compatibility equation.
   Stress- strain relation and the general equation of elasticity. Generalized Hooke's law in terms of engineering constant, formulation of elasticity problem. Existence and uniqueness of solution, Saint- Venant's principle. Principle of superposition and reciprocal theorem. **13 Hours**

2. **Plane stress and plane strain problems:** Bending of narrow cantilever beam under end load, simply supported beam with uniform load, use of Fourier series to solve two dimensional problems. Two dimensional problems in polar coordinates. Thin cylinder, pure bending of curved bar, rotating disc and cylinder, bending of curved bar by a force at the end, edge dislocation, effect of circular holes on stress distribution in plates, and vertical load of the straight boundary, forces acting on the end of wedge, stresses in circular disc. Thermal stresses- field equation, stresses in thin disk and long cylinder. 2-D problems in curvilinear coordinates. **13 Hours**

3. Torsion of prismatic bars, membrane analogy, torsion of thin open and closed tubes. **08 Hours**

4. Introduction to pure bending and deflection of plates and shells. **08 Hours**

5. Buckling of struts, stresses and strains in thick curved beam, cylinders and spheres. **08 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

TEXT BOOKS

1. Sadhu Singh, Theory of Elasticity, Khanna publisher
2. Applied elasticity- Wang C.T, Mc Graw Hill book company
3. L S Srinath "Advanced Mechanics of Solids " - Tata McGraw Hill Company.

REFERENCES

1. Theory of elasticity- Timoshenko and Goodier
2. Theory of plates and shells- Timoshenko, Mc Graw Hill book company
3. Dym C. L and Shames. I. H, Solid Mechanics: A variation Approach – McGraw Hill New York-1973.

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO1	Apply basic concepts in continuum mechanics of solids viz. Stress and strain tensors, equilibrium, compatibility and constitutive equations. Mohr's diagram hook's law and methods of solution to elasticity problems, principle of superposition and reciprocal theorem.
CO 2	Study about bending of cantilever beams with different loading condition. Evaluate stresses and displacements in simple solids such as pressurized cylinders, shrink fitted cylinders, rotating disc and shaft, plate with hole and non-circular shafts and thin tubes under torsion.
CO 3	To understand an analyze the Torsion of prismatic bars, membrane analogy, torsion of thin open and closed tubes
CO 4	To understand the stresses developed due to pure bending and deflection of plates and shells.
CO 5	To understand the concepts of Buckling of struts, stresses and strains in thick curved beam, cylinders and spheres.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-3, Chapter-,4 Chapter-5, are compulsory, with one question from each chapter
4. Chapter-1 and Chapter-2: two questions to be set with choice.

FINITE ELEMENT METHOD

Course Code	**:**	**16MMD12**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objectives

1. To present the Finite element method (FEM) as a numerical method for engineering analysis of continua and structures
2. To present Finite element formulation using variational and weighted residual approaches
3. To present Finite elements for the analysis of bars & trusses, beams & frames, plane stress & plane strain problems and 3-D solids, for thermal and dynamics problems.

Course Content: Chapters/ Units

1. **Approximations and round off errors**: Significant figures, accuracy and precision, error definitions, round off errors and truncation errors. Mathematical modeling and Engineering problem solving: Simple mathematical model, Conservation Laws of Engineering**.** **06 Hours**
   System of Linear Algebraic Equations and Eigen Value Problems: Introduction, Direct methods, Cramer's Rule, Gauss Elimination Method, Gauss-Jordan Elimination Method, Triangularization method, Cholesky Method, Partition method, error Analysis for direct methods, Iteration Methods. Eigen values and Eigen Vectors: Bounds on Eigen Values, Jacobi method for symmetric matrices. **06 Hours**

2. **Introduction to Finite Element Method:** Basic Steps in Finite Element Method to solve mechanical engineering (Solid, Fluid and Heat Transfer) problems: Functional approach and Galerkin approach, Displacement Approach: Admissible Functions, Convergence Criteria: Conforming and Non-Conforming elements, C_o C_1 and C_n Continuity Elements. Basic Equations, Element Characteristic Equations, Assembly Procedure, Boundary and Constraint Conditions.
   06 Hours
   Solid Mechanics: One-Dimensional Finite Element Formulations and Analysis – Bars- uniform, varying and stepped cross section-Basic (Linear) and Higher Order Elements Formulations for Axial, Torsional and Temperature Loads with problems. Beams- Basic (Linear) Element Formulation-for uniform, varying and stepped cross section- for different loading and boundary conditions with problems. Trusses, Plane Frames and Space Frame Basic (Linear) Elements Formulations for different boundary condition -Axial, Bending, Torsional, and Temperature Loads with problems. **06 Hours**

3. **Two-Dimensional Finite Element Formulations for Solid Mechanics Problems:** Triangular Membrane (TRIA 3, TRIA 6, TRIA 10) Element, Four-Noded Quadrilateral Membrane (QUAD 4, QUAD 8) Element Formulations for in-plane loading with sample problems.
   Triangular and Quadrilateral, Axis-symmetric basic and higher order Elements formulation for axis-symmetric loading only with sample problems.
   Three-Dimensional Finite Element Formulations for Solid Mechanics Problems: Finite Element Formulation of Tetrahedral Element (TET 4, TET 10), Hexahedral Element (HEXA 8, HEXA 20), for different loading conditions. Serendipity and Lagrange family Elements
   10 Hours

4. **Finite Element Formulations for Structural Mechanics Problems:** Basics of plates and shell theories: Classical thin plate Theory, Shear deformation Theory and Thick Plate theory. Finite Element Formulations for triangular and quadrilateral Plate elements. Finite element formulation of flat, curved, cylindrical and conical Shell elements **08 Hours**
5. **Dynamic Analysis:** Finite Element Formulation for point/lumped mass and distributed masses system, Finite Element Formulation of one-dimensional dynamic analysis: bar, truss, frame and beam element. Finite Element Formulation of Two-dimensional dynamic analysis: triangular membrane and axisymmetric element, quadrilateral membrane and axisymmetric element. Evaluation of eigen values and eigen vectors applicable to bars, shaft, beams, plane and space frame. **10 Hours**

NOTE: students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry.

Text Books:

1. S.S. Sastry, Introductory Methods of Numerical Analysis, PHI, 2005.
2. Steven C. Chapra, Raymond P. Canale, Numerical Methods for Engineers, Tata McGraw Hill, 4th Ed, 2002.
3. M K Jain, S.R.K Iyengar, R K. Jain, Numerical methods for Scientific and engg computation, New Age International, 2003.
4. T. R. Chandrupatla and A. D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall, 3rd Ed, 2002.
5. Lakshminarayana H. V., Finite Elements Analysis– Procedures in Engineering, Universities Press, 2004.

Reference Books:

1. Rao S. S., Finite Elements Method in Engineering- 4th Edition, Elsevier, 2006
2. P. Seshu, Textbook of Finite Element Analysis, PHI, 2004.
3. Bathe K. J., Finite Element Procedures, Prentice-Hall, 2006.
4. Cook R. D., Finite Element Modeling for Stress Analysis, Wiley,1995.
5. David. C. Lay, Linear Algebra and its applications, 3rd edition, Pearson Education, 2002

Course Outcomes:

Upon completion of this course, the students will be able to

CO1	It's important for the students to have basic knowledge about applied mathematics
CO2	Apply basic concepts about developing governing equations by finite element method, Formulate and perform one dimensional,
CO3	Two-dimensional structural analysis using bar, beam, triangular and quadrilateral elements. for Solid Mechanics Problems
CO4	Formulate axisymmetric triangular element and analyze problems on solids of revolution.
CO5	Formulate mass matrices and compute eigen values and eigen vectors for a 1- D and 2D analysis of mechanical system.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-3, Chapter-4, Chapter-5, are compulsory, with one question from each chapter
4. Chapter-1 and Chapter-2: two questions to be set with choice.

ADVANCED DESIGN OF MECHANISM

Course Code	**:**	**16MMD13**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:
To include dynamics considerations in the design of mechanisms for engineering applications is the objective of this course.

Course Content: Chapters/ Units

1. **Geometry of Motion:** Introduction, analysis and synthesis, Mechanism terminology, planar, Spherical and spatial mechanisms, mobility, Grashoffs law, Equivalent mechanisms, Unique mechanisms, Kinematic analysis of plane mechanisms: Auxiliary point method using rotated velocity vector, Hall - Ault auxiliary point method, Goodman's indirect method. **8 Hours**

   6 Hours

2. **Generalized Principles of Dynamics:** Fundamental laws of motion, generalized coordinates, Configuration space, Constraints, Virtual work, principle of virtual work, Energy and momentum, Work and kinetic energy, Equilibrium and stability, Kinetic energy of a system, Angular momentum, Generalized momentum. Lagrange's Equation: Lagrange's equation from D'Alembert's principles, Examples, Hamilton’s equations, Hamilton’s principle, Lagrange's, equation from Hamilton’s principle, Derivation of Hamiltons equations, Examples. **13 Hours**

3. **System Dynamics:** Gyroscopic action in machines, Euler's equation of motion, Phase Plane representation, Phase plane Analysis, Response of Linear Systems to transient disturbances. Synthesis of Linkages: Type, number, and dimensional synthesis, Function generation, Path generation and Body guidance, Precision positions, Structural error, Chebyshev spacing, Two position synthesis of slider crank mechanisms, Crank-rocker mechanisms with optimum transmission angle Motion Generation: Poles and relative poles, Location of poles and relative poles, pooled, Curvature, Inflection circle. **13 Hours**

4. Graphical Methods of Dimensional Synthesis: Two position synthesis of crank and rocker mechanisms, three position synthesis, four position synthesis (point precision reduction) Overlay method, Coupler curve synthesis, Cognate linkages. Ana1ytical Methods of Dimensional Synthesis: Freudenstein's equation for four bar mechanism and slider crank mechanism, Examples, Bloch's method of synthesis, Analytical synthesis using complex algebra. **12 Hours**

5. Spatial Mechanisms: Introduction, Position analysis problem, Velocity and acceleration analysis, Eulerian angles. **6 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. Greenwood, "Classical Dynamics", Prentice Hall of India, 1988.
2. K.J. Waldron G.L. Kinzel, "Kinematics, Dynamics and Design of Machinery", Wiley India, 2007.

References Books:

1. J E Shigley, "Theory of Machines and Mechanism" -McGraw-Hill, 1995
2. A.G. Ambekar, "Mechanism and Machine Theory", PHI, 2007.
3. Ghosh and Mallick, "Theory of Mechanism and Mechan ism", East West press 2007.
4. David H. Myszka, "Machines and Mechanisms", Pearson Education, 2005.

Course Outcome:

Upon completion of this course, the student will be able to

CO1	The knowledge of dynamics considerations in mechanism design is essential to use commercial multi body dynamics software in mechanical engineering design.
CO2	Carry out mobility analysis of mechanism and perform velocity and acceleration of complex planer mechanism.
CO3	Synthesize mechanisms for function generation and path generation.
CO4	Analyze the Dynamics of Mechanical systems using D'Alembert's, Lagrange's, and Hamiltons Principles.
CO5	Demonstrate the skills to use software to analyze mechanisms, synthesis of linkages.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-1, Chapter-4, Chapter-5, are compulsory, with one question from each chapter
4. Chapter-2 and Chapter-3: two questions to be set with choice.

ADVANCED THEORY OF VIBRATIONS

Course Code	**:**	**16MMD14**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:

To teach students how to use the theoretical principles of vibration, and vibration analysis techniques, for the practical solution of vibration problems. The course thus builds on student's prior knowledge of vibration theory, and concentrates on the applications. Thus the student will fully understand the importance of vibrations in mechanical design of machine parts that operate in vibratory conditions.

Course Content: Chapters/ Units

1. **Review of Mechanical Vibrations:** Basic concepts; free vibration of single degree of freedom systems with and without damping, forced vibration of single DOF-systems, Natural frequency.
   Transient Vibration of single Degree-of freedom systems: Impulse excitation, Arbitrary excitation, Laplace transform formulation, pulse excitation and rise time, Shock response spectrum, Shock isolation. **10 Hours**

2. **Vibration Control:** Introduction, Vibration isolation theory, Vibration isolation and motion isolation for harmonic excitation, practical aspects of vibration analysis, shock isolation, Dynamic vibration absorbers, Vibration dampers.
   Vibration Measurement and applications: Introduction, Transducers, Vibration pickups, Frequency measuring instruments, Vibration exciters, Signal analysis. **13 Hours**

3. **Modal analysis & Condition Monitoring:** Dynamic Testing of machines and Structures, Experimental Modal analysis, Machine Condition monitoring and diagnosis. Non-Linear Vibrations: Introduction, Sources of nonlinearity, Qualitative analysis of nonlinear systems. Phase plane, Conservative systems, Stability of equilibrium, Method of isoclines, Perturbation method, Method of iteration, Self-excited oscillations. **13 Hours**

4. **Random Vibrations:** Random phenomena, Time averaging and expected value, Frequency response function, Probability distribution, Correlation, Power spectrum and power spectral density, Fourier transforms, FTs and response. **08 Hours**
5. **Continuous Systems:** Vibrating string, longitudinal vibration of rods, Torsional vibration of rods, Euler equation for beams.
   Different methods of vibration dissipation in structural components for general and rotating machinery. **08 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. Theory of Vibration with Application, - William T. Thomson, Marie Dillon Dahleh, Chandramouli Padmanabhan, 5th edition Pearson Education
2. S. Graham Kelly, "Fundamentals of Mechanical Vibration" - McGraw-Hill, 2000
3. S. S. Rao, "Mechanical Vibrations", Pearson Education, 4th edition.

Reference Books:

1. S. Graham Kelly, "Mechanical Vibrations", Schaum's Outlines, Tata McGraw Hill, 2007.
2. C Sujatha , "Vibrations and Acoustics – Measurement s and signal analysis Tata McGraw Hill, 2010

Course Outcome:

Upon completion of this course, the student will be able to

CO1	Model and analyze a free damped, undamped and forced response of a mechanical system.
CO2	Develop equation and analyze the transient response of a single degree freedom system.
CO3	Assess the response characteristics of a continuous mechanical system.
CO4	Analyze and discuss the behavior of single degree freedom system for linear and non-linear behavior.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-1, Chapter-4, Chapter-5, are compulsory, with one question from each chapter
4. Chapter-2 and Chapter-3: two questions to be set with choice.

Elective-I

MECHATRONICS SYSTEMS DESIGN

Course Code	**:**	**16MMD151**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective

1. To educate the student regarding integration of mechanical, electronic, electrical and computer systems in the design of CNC machine tools, Robots etc.
2. To provide students with an understanding of the Mechatronic Design Process, actuators, Sensors, transducers, Signal Conditioning, MEMS and Microsystems and also the Advanced Applications in Mechatronics.

Course Content: Chapters/ Units

1. **Introduction:** Definition and Introduction to Mechatronic Systems. Modeling &Simulation of Physical systems Overview of Mechatronic Products and their functioning, measurement systems. Control Systems, simple Controllers. Study of Sensors and Transducers: Pneumatic and Hydraulic Systems, Mechanical Actuation System, Electrical Actual Systems, Real time interfacing and Hardware components for Mechatronics. **13 Hours**

2. **Electrical Actuation Systems:** Electrical systems, Mechanical switches, Solid state switches, solenoids, DC & AC motors, Stepper motors.
   System Models: Mathematical models: - mechanical system building blocks, electrical system building blocks, thermal system building blocks, electromechanical systems, hydro-mechanical systems, pneumatic systems. **10 Hours**

3. **Signal Conditioning:** Signal conditioning, the operational amplifier, Protection, Filtering, Wheatstone Bridge, Digital signals, Multiplexers, Data Acquisition, Introduction to digital system processing, pulse-modulation.
   MEMS and Microsystems: Introduction, Working Principle, Materials for MEMS and Microsystems, Micro System fabrication process, Overview of Micro Manufacturing, Micro system Design, and Micro system Packaging. **13 Hours**

4. **Data Presentation Systems:** Basic System Models, System Models, Dynamic Response of system. **8 Hours**

5. **Advanced Applications in Mechatronics:** Fault Finding, Design, Arrangements and Practical Case Studies, Design for manufacturing, User-friendly design **8 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. W. Bolton, “Mechatronics” - Addison Wesley Longman Publication, 1999
2. HSU “MEMS and Microsystems design and manufacture”- Tata McGraw-Hill Education, 2002

Reference Books:

1. Kamm, “Understanding Electro-Mechanical Engineering an Introduction to Mechatronics”- IEEE Press, 1 edition ,1996
2. Shetty and Kolk “Mechatronics System Design”- Cengage Learning, 2010
3. Mahalik “Mechatronics”- Tata McGraw-Hill Education, 2003
4. HMT “Mechatronics”- Tata McGraw-Hill Education, 199 8
5. Michel.B. Histand& David. Alciatore, “Introduction to Mechatronics & Measurement Systems”–. Mc Graw Hill, 2002
6. “Fine Mechanics and Precision Instruments”- Pergamon Press, 1971.

Course Outcome:

Upon completion of this course, the student will be able to

CO1	Appreciate multi-disciplinary nature of modern engineering systems.
CO2	Model and analyze mechanical and electrical systems and their connection.
CO3	Be able to integrate mechanical, electronics, control and computer engineering in the design of mechatronics systems.
CO4	Address issues of design, fabrication, and packaging issues of Microsystems.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-2, Chapter-4, Chapter-5, are compulsory, with one question from each chapter
4. Chapter-1 and Chapter-3: two questions to be set with choice.

DESIGN FOR MANUFACTURE

Course Code	**:**	**16MMD152**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:

To educate students a clear understanding of factors to be considered in designing parts and components with focus on manufacturability

Course Content: Chapters/ Units

1. **Effect of Materials and Manufacturing Process on Design:** Major phases of design. Effect of material properties on design Effect of manufacturing processes on design. Material selection process- cost per unit property, weighted properties and limits on properties methods.
   Tolerance Analysis: Process capability, mean, variance, skewness, kurtosis, Process capability metrics, Cp, Cpk, Cost aspects, Feature tolerances, Geometries tolerances, Geometric tolerances, Surface finish, Review of relationship between attainable tolerance grades and different machining process. Cumulative effect of tolerance- Sure fit law and truncated normal law.
   13 Hours

2. **Selective Assembly:** Interchangeable part manufacture and selective assembly, Deciding the number of groups -Model-1 : Group tolerance of mating parts equal, Model total and group tolerances of shaft equal. Control of axial play-Introducing secondary machining operations, laminated shims, examples.
   Datum Features: Functional datum, Datum for manufacturing, changing the datum. Examples.
   12 Hours

3. **Design Considerations**: Design of components with casting consideration. Pattern, Mould, and Parting line. Cored holes and machined holes. Identifying the possible and probable parting line. Casting requiring special sand cores. Designing to obviates and cores.
   Component Design: Component design with machining considerations link design for turning components-milling, Drilling and other related processes including finish- machining operations.
   13 Hours
4. True positional theory: Comparison between co-ordinate and convention method of feature location. Tolerance and true position tolerancing virtual size concept, Floating and fixed fasteners. Projected tolerance zone. Assembly with gasket, zero position tolerance. Functional gauges, Paper layout gauging. **7 Hours**

5. Design of Gauges: Design of gauges for checking components in assemble with emphasis on various types of limit gauges for both hole and shaft. **7 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. Harry Peck, “Designing for Manufacturing”, Pitman Publications, 1983.
2. Dieter, “Machine Design” - McGraw-Hill Higher Education, -2008
3. R.K. Jain, “Engineering Metrology", Khanna Publishers, 1986

Reference Books:

1. Product design for manufacture and assembly - Geoffrey Boothroyd, Peter dewhurst, Winston Knight, Merceldekker. Inc. CRC Press, Third Edition
2. Material selection and Design, Vol. 20 - ASM Hand book.

Course Outcomes:

Upon completion of this course, the student will be able to

CO1	Understand the role of manufacture and assembly in development of mechanical parts and their assemblies.
CO2	Apply manufacturing considerations in the design and development of components made of casting and machining.
CO3	Apply geometrical dimensioning and tolerances issues in mechanical design.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

5. Seven FULL questions to be set.
6. Five FULL questions to be answered.
7. Chapter-2, Chapter-4, Chapter-5, are compulsory, with one question from each chapter
8. Chapter-1 and Chapter-3: two questions to be set with choice.

AUTOMOBILE SYSTEM DESIGN

Course Code	**:**	**16MMD153**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:
This course would facilitate understanding of the stages involved in automobile system design. The student will be exposed to industrial practices in design of various systems of an automobile.

Course Content: Chapters/ Units

1. Body Shapes: Aerodynamic Shapes, drag forces for small family cars.
Fuel Injection: Spray formation, direct injection for single cylinder engines (both SI & CI), energy audit. **10 Hours**

2. Design of I.C. Engine I: Combustion fundamentals, combustion chamber design, cylinder head design for both SI & C. I. Engines. **8 Hours**

3. Design of I.C. Engine II: Design of crankshaft, camshaft, connecting rod, piston & piston rings for small family cars (max up to 3cylinders). **12 Hours**

4. Transmission System: Design of transmission systems – gearbox (max of 4-speeds), differential.
Suspension System: Vibration fundamentals, vibration analysis (single & two degree of freedom, vibration due to engine unbalance, application to vehicle suspension. **12 Hours**

5. Cooling System: Heat exchangers, application to design of cooling system (water cooled).
Emission Control: Common emission control systems, measurement of missions, exhaust gas emission testing. **10 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. **Design of Automotive Engines**, **-** A. Kolchin& V. Demidov, MIR Publishers, Moscow
2. **The motor vehicle, Newton steeds & Garratte -** Ili fee& sons Ltd., London
3. **I.C. Engines -** Edward F Obert, International text book company.

Reference Books:

1. **Introduction to combustion** - Turns
2. **Automobile Mechanic -**, N.K. Giri, Khanna Publications, 1994
3. **I.C. Engines** - Maleev, McGraw Hill book company, 1976
4. **Diesel engine design** – Heldt P.M. Chilton company New York.
5. **Problems on design of machine elements -** V.M. Faires & Wingreen, McMillan Company., 1965
6. **Design of I.C. Engines -** John Heywood, TMH

Course Outcome:

Upon completion of this course, the student will be able to

CO1	The student will be able to apply the knowledge in creating a preliminary design of automobile sub systems.
CO2	Students are exposed to aerodynamic analysis of the auto mobiles.
CO3	Students are exposed to engine performances, combustion analysis and exhaust gas analysis to meet the BIS standards (10000 series).

<u>SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)</u>

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-1, Chapter-2, Chapter-5, are compulsory, with one question from each chapter
4. Chapter-3 and Chapter-4: two questions to be set with choice.

Design Engineering Laboratory – Lab 1

Course Code	**:**	**16MMDL16**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 0:0:3**		**SEE Marks**	**:**	**50**
Credits	**:**	**02**		**SEE Duration**	**:**	**3 hours**

Note:

1) These are independent laboratory exercises
2) A student may be given one or two problems stated herein
3) Student must submit a comprehensive report on the problem solved and give a Presentation on the same for Internal Evaluation
4) Any one of the exercises done from the following list has to be asked in the Examination for evaluation.

Course Content:

Experiment #1
Vibration analysis using portable vibration meter with FFT analyzer.

Experiment #2
Modal analysis

Experiment #3
Vibration analysis using accelerometers

- **a)** Uni-axial
- **b)** Tri-axial
- **c)** High temperature Tri-axial

Experiment #4
Vibration Shaker

Experimental #5
Vibration analysis on Beams

Experiment #6
Torsional vibration

Experiment #7
Vibration Characteristics of a Spring Mass Damper System.
Part A: Analytical Solutions.
Part C: Correlation Studies.

Experiment #8
Stress analysis in curved beam in 2D
Part A: Experimental studies using Strain Gauge Instrumentation.
Part B: 2D Photo elastic Investigation.

TECHNICAL SEMINAR

Course Code	**:**	**16MMDS17**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: S 0:0:0:3**		**SEE Marks**	**:**	**50**
Credits	**:**	**02**		**SEE Duration**	**:**	**3 hours**

- **Seminar**: At the end of second CIE each student is required to present the seminar of his/her interested field (Related to design subjects).
- Report submissions and final Evaluation is to be carried out by the Internal Guide of the college and a senior faculty along with HOD.

MINI PROJECT/ INDUSTRIAL VISIT/ FIELD WORK

Course Code	**:**	**16MMDM18**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: S 0:0:0:3**		**SEE Marks**	**:**	**50**
Credits	**:**	**02**		**SEE Duration**	**:**	**3 hours**

- **Industrial Visit**: At the end of second CIE the industrial visit will be arranged in the domain field, each student is required to submit the report of the visit.
- Report submissions and final Evaluation is to be carried out by the Internal Guide of the college and a senior faculty along with HOD.

II Semester

COMPOSITE MATERIALS TECHNOLOGY

Course Code	**:**	**16MMD21**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:
Mechanics of composite materials provides a methodology for stress analysis and progressive failure analysis of laminated composite structures for aerospace, automobile, marine and other engineering applications.

Course Content: Chapters/ Units

1. **Introduction to Composite Materials:** Definition, Classification, Types of matrices material and reinforcements, Characteristics &selection, Fiber composites, laminated composites, Particulate composites, Prepegs, and sandwich construction.

Metal Matrix Composites: Reinforcement materials, Types, Characteristics and selection, Base metals, Selection, Applications

Macro Mechanics of a Lamina: Hooke's law for different types of materials, Number of elastic constants, Derivation of nine independent constants for orthotropic material, Two - dimensional relationship of compliance and stiffness matrix. Hooke's law for two-dimensional angle lamina, engineering constants - Numerical problems. Invariant properties. Stress-Strain relations for lamina of arbitrary orientation, Numerical problems. **10 Hours**

2. **Micro Mechanical Analysis of a Lamina:** Introduction, Evaluation of the four elastic moduli, Rule of mixture, Numerical problems. Experimental Characterization of Lamina- Elastic Moduli and Strengths

Failure Criteria: Failure criteria for an elementary composite layer or Ply, Maximum Stress and Strain Criteria, Approximate strength criteria, Inter-laminar Strength, Tsa-Hill theory, Tsai, Wu tensor theory, Numerical problem, practical recommendations. **12 Hours**

3. Macro Mechanical Analysis of Laminate: Introduction, code, Kirchoff hypothesis, Classical Lamination Theory, A, B, and D matrices (Detailed derivation), Special cases of laminates, Numerical problems. Shear Deformation Theory, A, B, D and E matrices (Detailed derivation)

10 Hours

4. **Analysis of Composite Structures:** Optimization of Laminates, composite laminates of uniform strength, application of optimal composite structures, composite pressure vessels, spinning composite disks, composite lattice structures. **8 Hours**

5. **Manufacturing and Testing:** Layup and curing - open and closed Mould processing, Hand lay-up techniques, Bag moulding and filament winding. Pultrusion, Pulforming, Thermoforming, Injection moulding, Cutting, Machining, joining and repair. NDT tests – Purpose, Types of defects, NDT method - Ultrasonic inspection, Radiography, Acoustic emission and Acoustic ultrasonic method.

Applications: Aircrafts, missiles, Space hardware, automobile, Electrical and Electronics, Marine, Recreational and sports equipment-future potential of composites. **12 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. Autar K. Kaw, Mechanics of Composite materials, CRC Press, 2nd Ed, 2005.
2. Madhijit Mukhopadhay, Mechanics of Composite Materials & Structures, Universities Press, 2004.

Reference Books:

1. J. N. Reddy, Mechanics of Laminated Composite Plates & Shells, CRD Press, 2nd Ed, 2004.
2. Mein Schwartz, Composite Materials handbook, McGraw Hill, 1984.
3. Rober M. Jones, Mechanics of Composite Materials, Taylor & Francis, 1998.
4. Michael W, Hyer, Stress analysis of fiber Reinforced Composite Materials, Mc-Graw Hill International, 2009.
5. Composite Material Science and Engineering, Krishan K. Chawla, Springer, 3e, 2012.
6. Fiber Reinforced Composites, P.C. Mallik, Marcel Decker, 1993.

Course Outcomes:

Upon completion of this course, the student will be able to

CO1	Identify the role of matrices and reinforcements used in practical composite structures.
CO2	Analyze problems on micro and macro mechanical behavior of lamina.
CO3	Assess the strength of laminated composite and predict its failure for given static loading conditions.
CO4	Develop understanding of different methods of manufacturing and testing of composites.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-1, Chapter-3, Chapter-4, are compulsory, with one question from each chapter
4. Chapter-2 and Chapter-5: two questions to be set with choice.

ADVANCED MACHINE DESIGN

Course Code	**:**	**16MMD22**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:
This course enables the student to identify failure modes and evolve design by analysis methodology. Design against fatigue failure is given explicit attention.

Course Content: Chapters/ Units

1. **Introduction:** Role of failure prevention analysis in mechanical design, Modes of mechanical failure, Review of failure theories for ductile and brittle materials including Mohr's theory and modified Mohr's theory, Numerical examples.
   Fatigue of Materials: Introductory concepts, High cycle and low cycle fatigue, Fatigue design models, Fatigue design methods, Fatigue design criteria, Fatigue testing, Test methods and standard test specimens, Fatigue fracture surfaces and macroscopic features, Fatigue mechanisms and microscopic features. **12 Hours**

2. **Stress-Life (S-N) Approach:** S-N curves, Statistical nature of fatigue test data, General S-N behavior, Mean stress effects, Different factors influencing S-N behavior, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using S-N approach.
   Strain-Life(ε-N) approach: Monotonic stress-strain behavior, Strain controlled test methods, Cyclic stress-strain behavior, Strain based approach to life estimation, Determination of strain life fatigue properties, Mean stress effects, Effect of surface finish, Life estimation by ε-N approach.
   13 Hours

3. **LEFM Approach:** LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress effects, Crack growth life estimation. Notches and their effects: Concentrations and gradients in stress and strain, S-N approach for notched membranes, mean
   stress effects and Haigh diagrams, Notch strain analysis and the strain – life approach, Neuber's rule, Glinka's rule, applications of fracture mechanics to crack growth at notches. **13 Hours**

4. **Fatigue from Variable Amplitude Loading:** Spectrum loads and cumulative damage, Damage quantification and the concepts of damage fraction and accumulation, Cumulative damage theories, Load interaction and sequence effects, Cycle counting methods, Life estimation
   using stress life approach. **7 Hours**

5. **Surface Failure:** Introduction, Surface geometry, Mating surface, Friction, Adhesive wear, Abrasive wear, Corrosion wear, Surface fatigue spherical contact, cylindrical contact, General contact, Dynamic contact stresses, Surface fatigue strength. **7 Hours**

NOTE: Students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. Ralph I. Stephens, Ali Fatemi, Robert, Henry o. Fuchs, "Metal Fatigue in engineering", John Wiley New York, Second edition. 2001.
2. Failure of Materials in Mechanical Design, Jack. A. Collins, John Wiley, New York 1992.
3. Robert L. Norton, "Machine Design", Pearson Education India, 2000

Reference Books:

1. Suresh, "Fatigue of Materials", Cambridge University Press, -1998
2. Julie. A. Benantine, "Fundamentals of Metal Fatigue Analysis", Prentice Hall,1990
3. Fatigue and Fracture, ASM Hand Book, Vol 19,2002.

Course Outcomes:

Upon completion of this course, the student will be able to

CO1	Predict failure of engineering components using appropriate failure theories.
CO2	Identify and explain the types of fractures of engineered materials and their characteristic features;
CO3	Estimate life of components using stress life, strain life and LEFM approach.
CO4	Categorize different types of surface failures.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-1, Chapter-4, Chapter-5, are compulsory, with one question from each chapter
4. Chapter-2 and Chapter-3: two questions to be set with choice.

EXPERIMENTAL MECHANICS

Course Code	**:**	**16MMD23**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:

This course aims at a comprehensive study of mechanics of solids. The objective of this course is to familiarize the student with state-of-the-art experimental techniques namely strain gauges, photo elasticity, moiré interferometry, brittle coating, moiré fringes and holography.

Course Content: Chapters/ Units

1. **Introduction**: Definition of terms, calibration, standards, dimension and units, generalized measurement system, Basic concepts in dynamic measurements, system response, distortion, impedance matching, experiment planning.
   Analysis of Experimental Data: Cause and types of experimental errors, error analysis. Statistical analysis of experimental data- Probability distribution, gaussian, normal distribution. Chi-square test, Method of least square, correlation coefficient, multivariable regression, standard deviation of mean, graphical analysis and curve fitting, general consideration in data analysis. **12 Hours**

2. **Data Acquisition and Processing:** General data acquisition system, signal conditioning revisited, data transmission, Analog-to-Digital and Digital-to- Analog conversion, Basic components (storage and display) of data acquisition system. Computer program as a substitute for wired logic.
   Force, Torque and Strain Measurement: Mass balance measurement, Elastic Element for force measurement, torque measurement. Strain Gages -Strain sensitivity of gage metals, Gage construction, Gage sensitivity and gage factor, Performance characteristics, Environmental effects Strain, gage circuits, Potentiometer, Wheat Stone's bridges, Constant current circuits. Strain Analysis Methods-Two element and three element, rectangular and delta rosettes, Correction for transverse strains effects, stress gage - plane shear gage, Stress intensity factor gage. **12 Hours**

3. **Stress Analysis:** Two-Dimensional Photo elasticity **-** Nature of light, - wave theory of light, - optical interference - Polariscopes stress optic law - effect of stressed model in plane and circular Polariscopes, Isoclinic chromatics fringe order determination - Fringe multiplication techniques - Calibration Photo elastic model materials. Separation methods shear difference method, Analytical separation methods, Model to prototype scaling**.** **10 Hours**

4. **Three-Dimensional Photo elasticity:** Stress freezing method, General slice, Effective stresses, Stresses separation, Shear deference method, Oblique incidence method Secondary principals' stresses, Scattered light photo elasticity, Principals, Polari scope and stress data analyses**.** **8 Hours**

5. **Coating Methods:** a) Photo elastic Coating Method-Birefringence coating techniques Sensitivity Reinforcing and thickness effects – data reduction - Stress separation techniques Photo elastic strain gauges. b) Brittle Coatings Method: Brittle coating technique Principles data analysis - coating materials, Coating techniques. c) Moire Technique - Geometrical approach, Displacement approach- sensitivity of Moire data reduction, In plane and out plane Moire methods, Moire photography, Moire grid production.

Holography: Introduction, Equation for plane waves and spherical waves, Intensity, Coherence, Spherical radiator as an object (record process), Hurter, Driffield curves, Reconstruction process, Holographic interferometry, Realtime. and double exposure methods, Displacement measurement, Isopachics. **10 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. **Holman,** "Experimental Methods for Engineers" 7^{th}Edition, Tata McGraw-Hill Companies, Inc, New York, 2007.
2. **R. S. Sirohi, H. C. Radha Krishna,** "Mechanical measurements" New Age International Pvt. Ltd., New Delhi, 2004
3. **Experimental Stress Analysis** - Srinath, Lingaiah, Raghavan, Gargesa, Ramachandra and Pant, Tata McGraw Hill, 1984.
4. **Instrumentation, Measurement and Analysis -**Nakra &Chaudhry, B C Nakra K Chaudhry, Tata McGraw-Hill Companies, Inc, New York, Seventh Edition, 2006.

Reference Books:

1. **Measurement Systems Application and Design -** Doeblin E. A., 4th (S.I.) Edition, McGraw Hill, New York. 1989
2. **Design and Analysis of Experiments -** Montgomery D.C., John Wiley & Sons, 1997.
3. **Experimental Stress Analysis** - Dally and Riley, McGraw Hill, 1991.
4. **Experimental Stress Analysis -** Sadhu Singh, Khanna publisher, 1990.
5. **Photoelasticity Vol I and Vol II -** M.M. Frocht, John Wiley and sons, 1969.
6. **Strain Gauge Primer -** Perry and Lissner, McGraw Hill, 1962.

Course Outcomes:

Upon completion of this course, the student will be able to

CO1	Understand functional requirements of a generalized measurement system and identify suitable components for an application.
CO2	Use concepts of Data Acquisition, Processing and apply the same for interpretation and analysis of experimental data.
CO3	Determine stresses and strains in a structure using different methods such as strain gages, photo-elasticity, brittle coating and holography.
CO4	Identify and apply suitable experimental stress analysis to practical problems

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-3, Chapter-4, Chapter-5, are compulsory, with one question from each chapter
4. Chapter-1 and Chapter-2: two questions to be set with choice.

TRIBOLOGY AND BEARING DESIGN

Course Code	**:**	**16MMD24**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:

Gives in-depth knowledge regarding hydrodynamic, hydrostatic lubrication and various bearings, with their design and applications

Course Content: Chapters/ Units

1. **Introduction to Tribology:** Introduction, Friction, Wear, Wear Characterization, Regimes of lubrication, Classification of contacts, lubrication theories, Effect of pressure and temperature on viscosity. Newton's Law of viscous forces, Flow through stationary parallel plates. Hagen's Poiseuille's theory, viscometers. Numerical problems, Concept of lightly loaded bearings, Petroff's equation, Numerical problems. **8 Hours**

2. **Hydrodynamic Lubrications:** Pressure development mechanism. Converging and diverging films and pressure induced flow. Reynolds's 2D equation with assumptions. Introduction to idealized slide bearing with fixed shoe and Pivoted shoes. Expression for load carrying capacity. Location of center of pressure, effect of end leakage on performance, Numerical problems

   Journal Bearings: Introduction to idealized full journal bearings. Load carrying capacity of idealized full journal bearings, Sommer Feld number and its significance, short and partial bearings, Comparison between lightly loaded and heavily loaded bearings, effects of end leakage on performance, Numerical problems. **12 Hours**

3. **Hydrostatic Bearings:** Hydrostatic thrust bearings, hydrostatic circular pad, annular pad, rectangular pad bearings, types of flow restrictors, expression for discharge, load carrying capacity and condition for minimum power loss, numerical problems, and hydrostatic journal bearings.

   EHL Contacts: Introduction to Elasto- hydrodynamic lubricated bearings. Introduction to 'EHL' constant, Grubin type solution. **12 Hours**

4. **Antifriction bearings:** Advantages, selection, nominal life, static and dynamic load bearing capacity, probability of survival, equivalent load, cubic mean load, bearing mountings.

   Porous Bearings: Introduction to porous and gas lubricated bearings. Governing differential equation for gas lubricated bearings, Equations for porous bearings and working principal, Fretting phenomenon and its stages. **10 Hours**

5. **Magnetic Bearings:** Introduction to magnetic bearings, Active magnetic bearings. Different equations used in magnetic bearings and working principal. Advantages and disadvantages of magnetic bearings, Electrical analogy, Magneto-hydrodynamic bearings.

   Advanced bearing systems and their advantages over conventional bearing systems, testing of different types of bearings **10 hours**

NOTE: Students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books

1. Mujamdar.B.C "Introduction to Tribology of Bearing", Wheeler Publishing, New Delhi 2001
2. Radzimovsky, "Lubrication of Bearings - Theoretical principles and design" Oxford press Company, 2000

Reference Books

1. Dudley D. Fulier " Theory and practice of Lubrication for Engineers", New YorkCompany.1998
2. Moore "Principles and applications of Tribology" Pergamon press, 1975
3. Oscar Pinkus, Beno Sternlicht, “Theory of hydro dynamic lubrication”, McGraw-Hill, 1961
4. G W Stachowiak, A W Batchelor, “Engineering Tribology”, Elsevier publication 1993.
5. Hydrostatic and hybrid bearings, Butterworth 1983.
6. F. M. Stansfield, Hydrostatic bearings for machine tools and similar applications, Machinery Publishing, 1970

Course Outcome:

Upon completion of this course, the student will be able to

CO1	Students develop skills to design and selection of bearings on Various tribological factors to be considered in moving and rotating parts.
CO2	The students are exposed to orient towards the various types of bearings and their applications.
CO3	Students are exposed to synthesis and analysis of the bearings including fault diagnosis.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-1, Chapter-4, Chapter-5, are compulsory, with one question from each chapter
4. Chapter-2 and Chapter-3: two questions to be set with choice.

Elective-II

THEORY OF PLASTICITY

Course Code	**:**	**16MMD251**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:
This course focuses on stress-strain relations, yield criteria and associated flow rules for elastic-plastic analysis of components and structures

Course Content: Chapters/ Units

1. Definition and scope of the subject, Brief review of elasticity, Octahedral normal and shear stresses, Spherical and deviatoric stress, Invariance in terms of the deviatoric stresses, Idealized stress-strain diagrams for different material models, Engineering and natural strains, Mathematical relationships between true stress and true strains, Cubical dilation, finite strains co- efficient Octahedral strain, Strain rate and the strain rate tensor. **11 Hours**

2. Material Models, Stress-strain relations, Yield criteria for ductile metal, Von Mises, Tresca, Yield surface for an Isotropic Plastic materials, Stress space, Experimental verification of Yield criteria, Yield criteria for an anisotropic material, flow rule normality, Yield locus, Symmetry convexity, Deformation of isotropic and kinematic hardening, bilinear stress-strain relationship, power law hardening, deformation theory of plasticity, J2 flow theory, J2incremental theory. **11 Hours**

3. Plastic stress-strain relations, Prandtl-Rouss Saint Venant, Levy-Von Mises, Experimental verification of the Prandtl- Rouss equation Upper and lower bound theorems and corollaries, Application to problems Uni-axial tension and compression, Stages of plastic yielding. **10 Hours**

4. Bending of beams, Torsion of rods and tubes, Nonlinear bending and torsion equations, Simple forms of indentation problems using upper bounds, Application of Metal forming: Extrusion, Drawing, Rolling and Forging. **10 Hours**

5. Slip line theory, Introduction, Basic equations for incompressible two-dimensional flows, continuity equations, Stresses in conditions of plain Strain convention for slip-lines, Geometry of slip lines, Properties of slip lines, Computational Plasticity- Finite element method, Formulations, Plasticity models. **10 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books

1. Engineering Plasticity - Theory and Application to Metal Forming Process -R.A.C..Slater, McMillan Press Ltd., 1977
2. Theory of Plasticity and Metal forming Process - Sadhu Singh, Khanna Publishers, Delhi, 1999.

Reference Books

1. Introduction to the Theory of Plasticity for Engineers- Haffman and Sachs, LLC, 2012.
2. Theory of plasticity - J Chakrabarty, Butterworth, 2006.
3. Plasticity for Mechanical Engineers - Johnson and Mellor, Van Nostrand, 1966.

Course Outcomes:

Upon completion of this course, the student will be able to

CO1	Analyze and determine the elastic and elastoplastic stress- strain behavior of solid deformable bodies subjected to various types of loads.
CO2	Analyze and asses the yielding behavior in metallic material using suitable yield criteria.
CO3	Develop plastic stress-strain relation for large plastic deformation and apply same along with knowledge of yield criteria to various metal forming process.
CO4	Develop fundamental equations of slip line field theory.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-3, Chapter-4, Chapter-5, are compulsory, with one question from each chapter
4. Chapter-1 and Chapter-2: two questions to be set with choice.

ROTOR DYNAMICS

Course Code	**:**	**16MMD252**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:
This course is of interest to turbo machinery designers. Specifically modeling of bearings, shafts and rotor stages (compressors, turbines including blades) to predict instability like whirling including gyroscopic and corialis effect.

Course Content: Chapters/ Units

1. **Fluid Film Lubrication:** Basic theory of fluid film lubrication, Derivation of generalized Reynolds equations, Boundary conditions, Fluid film stiffness and Damping coefficients, Stability and dynamic response for hydrodynamic journal bearing, Two lobe journal bearings.
   Stability of Flexible Shafts: Introduction, equation of motion of a flexible shaft with rigid support, Radial elastic friction forces, Rotary friction, friction Independent of velocity, friction dependent on frequency, Different shaft stiffness Constant, gyroscopic effects, Nonlinear problems of large deformation applied forces, instability of rotors in magnetic field. **14 Hours**

2. **Critical Speed:** Dunkerley's method, Rayleigh's method, Stodola's method. Rotor Bearing System: Instability of rotors due to the effect of hydrodynamic oil layer in the bearings, support flexibility, Simple model with one concentrated mass at the center **6 Hours**

3. **Turbo rotor System Stability by Transfer Matrix Formulation:** General turbo rotor system, development of element transfer matrices, the matrix differential equation, effect of shear and rotary inertia, the elastic rotors supported in bearings, numerical solutions. **10 Hours**

4. **Turbo rotor System Stability by Finite Element Formulation:** General turbo rotor system, generalized forces and co-ordinates system assembly element matrices, Consistent mass matrix formulation, Lumped mass model, linearized model for journal bearings, System dynamic equations Fix stability analysis non dimensional stability analysis, unbalance response and Transient analysis. **14 Hours**

5. **Blade Vibration:** Centrifugal effect, Transfer matrix and Finite element, approaches. **8 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry.

Reference Books:

1. Cameron, “Principles of Lubrication”, Longman Publishing Group, 1986
2. Bolotin, “Nonconservative problems of the Theory of elastic stability”, Macmillan, 1963
3. Peztel, Lockie, “Matrix Methods in Elasto Mechanic s”, McGraw-Hill, 1963.
4. Timoshenko, “Vibration Problems in Engineering”, Ox ford City Press, 2011
5. Zienkiewicz, “The finite element method in engineering science”, McGraw-Hill, 1971

Course Outcomes:

Upon completion of this course, the student will be able to

CO1	Model a rotating machine element theoretically for rotor dynamic analysis.
CO2	Analyze Free and Forced lateral response of simple rotor models and of more complex systems including shafts, bearings, seals and stators.
CO3	Formulate Finite element and carry out analysis for Turborotor System Stability.
CO4	Apply Finite element approach to blade vibration.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-2, Chapter-3, Chapter-5, are compulsory, with one question from each chapter
4. Chapter-1 and Chapter-4: two questions to be set with choice.

FINITE ELEMENT METHODS FOR HEAT TRANSFER AND FLUID FLOW ANALYSIS

Course Code	**:**	**16MMD253**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:
The student will learn finite element formulation of various modes of heat transfer and fluid flow and to solve numerical examples.

Course Content: Chapters/ Units

1. **Introduction to Heat Transfer and Fluid Mechanics:** Mathematical Preliminaries, Governing equations of a continuum, Governing equation in terms of primitive variables, porous equations, low speed compressible flow equations, auxiliary transport equations, chemically reacting systems, boundary conditions, change of phase, enclosure radiation.
2. **Finite Element Methods:** Introduction, model differential equation, finite element approximations, interpolation functions, library of finite elements, modeling considerations, assembly of elements, numerical integration, discussion of results with some practical examples, time dependent problems.
12 Hours

2. **Steady State Conduction Heat Transfer:** Introduction, one dimensional linear, quadratic element. Homogeneous, composite wall with uniform and varying cross-sectional area. Radial heat flow in a cylinder. Conduction –convection systems. Numerical examples.
Conduction Heat Transfer: Interpolation functions for tetrahedral, hexahedral, pyramid and prism elements. Numerical integration, computation of surface flux, semi-discrete finite element model, solution of nonlinear equations for transient problems. Radiation algorithms. Variable properties.
12 Hours

3. **Advanced topic in Conduction:** specialty elements, computation of boundary conditions, bulk nodes, reactive materials, material motions Example problems on conduction, radiation, temperature dependent conductivity, anisotropic conduction, brazing and welding, investment casting. **8 Hours**

4. **Flows of Viscous Incompressible Fluids:** Governing equation, mixed finite element model, penalty finite element models. Finite element models of porous flow
Computational consideration: Interpolation functions for triangular, quadrilateral, tetrahedral and hexahedral elements. Evaluation of element matrices in penalty model, pressure calculation and traction boundary conditions. Numerical examples. **10 Hours**

5. **Coupled Fluid Flow and Heat Transfer:** Introduction to non-isothermal incompressible flows, governing equations and boundary condition. Mixed, penalty finite element model. Finite element model for porous flow. Non-isothermal low speed compressible flows: governing equation, boundary conditions, mixed finite element model and solution methods. Convection with change of phase, convection with enclosure radiation, turbulent heat transfer, chemically reacting systems. Numerical examples. **10 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. J N Reddy, David K. Gartling, "The finite element method in heat transfer and flu id dynamics", CRC, 2004.
2. Roland Wynne Lewis, Perumal Nithiarasu, K. N. Seetharamu," Fundamentals of the finite element method for heat and fluid flow"
   John Wiley, 2004

Reference Books:

1. Ching Jen Chen, R. A. Bernatz, "Finite analytic method in flows and heat transfer", Taylor & Francis.
2. Gianni Comini, Stefano Del Giudice, Carlo Nonino, "Finite Element Analysis in Heat Transfer: Basic Formulation and Linear problems" Taylorand Francis, 1994.

Course Outcomes:

Upon completion of this course, the student will be able to

CO1	This course enables the student to use numerical methods for solving problems of fluid flow and heat transfer.
CO2	Analyze of the continuum mechanics problems like fluid flow, heat transfer.
CO3	Analyze of incompressible and compressible fluids.
CO4	Analyze modes of conduction in various mechanical systems

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-3, Chapter-4, Chapter-5, are compulsory, with one question from each chapter
4. Chapter-1 and Chapter-2: two questions to be set with choice.

Design Engineering Laboratory - Lab 2

Course Code	**:**	**16MMDL26**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 0:0:3**		**SEE Marks**	**:**	**50**
Credits	**:**	**02**		**SEE Duration**	**:**	**3 hours**

Note:

1) These are independent laboratory exercises
2) A student may be given one or two problems stated herein
3) Student must submit a comprehensive report on the problem solved and give a Presentation on the same for Internal Evaluation
4) Any one of the exercises done from the following list has to be asked in the Examination for evaluation.

Course Content:

Experiment #1 Structural Analysis
Part A: FE Modeling of a stiffened Panel using a commercial preprocessor.
Part B: Buckling, Bending and Modal analysis of stiffened Panels.
Part C: Parametric Studies.

Experiment #2 Design Optimization
Part A: Shape Optimization of a rotating annular disk.
Part B: Weight Minimization of a Rail Car Suspension Spring.
Part C: Topology Optimization of a Bracket.

Experiment #3 Thermal analysis
Part A: Square Plate with Temperature Prescribed on one edge and Opposite edge insulated.
Part B: A Thick Square Plate with the Top Surface exposed to a Fluid at high temperature, Bottom Surface at room temperature, Lateral Surfaces Insulated.

Experiment #4 Thermal Stress Analysis
Part A: A Thick-Walled Cylinder with specified Temperature at inner and outer Surfaces.
Part B: A Thick-Walled Cylinder filled with a Fluid at high temperature and Outer Surface exposed to atmosphere.

Experiment#5 CFD Analysis
Part A: CFD Analysis of a Hydro Dynamic Bearing using commercial code.
Part B: Comparison of predicted Pressure and Velocity distributions with Target solutions.
Part C: Experimental Investigations using a Journal Bearing Test Rig.
Part D: Correlation Studies.

Experiment #6 Welded Joints.
Part A: Fabrication and Testing.
Part B: FE Modeling and Failure Analysis.
Part C: Correlation Studies.

Experiment #7 Bolted Joints.
Part A: Fabrication and Testing.
Part B: FE Modeling and Failure Analysis.
Part C: Correlation Studies.

Experiment #8 Adhesive Bonded Joints.
Part A: Fabrication and Testing.
Part B: FE Modeling and Failure Analysis.
Part C: Correlation Studies.

RESEARCH METHODOLOGY

Course Code	**:**	**RM 27**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 2:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**02**		**SEE Duration**	**:**	**3 hours**

Course Learning Objectives: Students are expected to

- Have a basic understanding of the underlying principles of quantitative and qualitative research
- Identify the overall process of designing a research study from its inception to its report.
- Choose the most appropriate research method to address a particular research question
- Gain a overview of a range of quantitative and qualitative approaches to data analysis

1. **Overview of Research:** Research and its types, identifying and defining research problem and introduction to different research designs. Essential constituents of Literature Review. Basic principles of experimental design, Primary data and Secondary Data, methods of primary data collection, classification of secondary data, designing questionnaires and schedules. **8 Hours**

2. **Sampling Methods:** Probability sampling: simple random sampling, systematic sampling, stratified sampling, cluster sampling and multistage sampling. Non-probability sampling: convenience sampling, judgment sampling, quota sampling. Sampling distributions. **6 Hours**

3. **Processing and analysis of Data:** Statistical measures and their significance: Central tendencies, variation, skewness, Kurtosis, time series analysis, correlation and regression, Testing of Hypotheses: Parametric (t and Chi Square). **6 Hours**

4. **Essential of Report writing and Ethical issues**: Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Ethical issues related to Research, Plagiarism and self- Plagiarism, Publishing. **6 Hours**

Reference Books:

1. Krishnaswami, K.N., Sivakumar, A. I. and Mathirajan, M., Management Research Methodology, Pearson Education: New Delhi.
2. Kothari C.R., Research Methodology Methods and techniques by, New Age International Publishers, 2nd edition
3. Levin, R.I. and Rubin, D.S., Statistics for Management, 7th Edition, Pearson Education: New Delhi.

Course Outcome:

At the end of the course students will:

CO1	Describe a range of quantitative and qualitative research designs and identify the advantages and disadvantages associated with these designs
CO2	Choose appropriate quantitative or qualitative method to collect data
CO3	Analyze and test the given data using appropriate methods
CO4	Design an appropriate mixed-method research study to answer a research question

MINI PROJECT/ INDUSTRIAL VISIT/ FIELD WORK

Course Code	**:**	**16MMDM28**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: S 0:0:0:3**		**SEE Marks**	**:**	**50**
Credits	**:**	**02**		**SEE Duration**	**:**	**3 hours**

- **Industrial Visit**: At the end of second CIE the industrial visit will be arranged in the domain field, each student is required to submit the report of the visit.
- Report submissions and final Evaluation is to be carried out by the Internal Guide of the college and a senior faculty along with HOD.

OR

- **Seminar**: At the end of second CIE each student is required to present the seminar of his/her interested field (Related to design subjects).
- Report submissions and final Evaluation is to be carried out by the Internal Guide of the college and a senior faculty along with HOD.

Semester III

INTERNSHIP

Internship: The student shall undergo internship for 16 weeks.

Preliminary Report submission and Evaluation after 8th week of Internship to be carried out by the Internal Guide of the college and a senior faculty for 100 marks

Final Report submission and Evaluation after 16th week of Internship to be carried out by the Internal Guide of the college and a senior faculty. Report Evaluation to be completed within two weeks of submission for 100 marks.

Viva-Voce on Internship - To be conducted by the Internship Guide (from the college) and the External Guide / Examiner within 2 weeks of Submission with a senior faculty / HOD as chairman for 100 marks

Project Phase: I

Problem formulation and submission of **synopsis** within 8 weeks from the commencement of 3rd semester, which shall be evaluated for 50 marks by the committee constituted for the purpose by the Head of the Department comprising the guide, senior faculty of the department with HOD as Chairman.

Literature survey and progress done after 16 weeks shall be evaluated by guide and external examiner with senior faculty / HOD as chairman for 100 marks.

IV Semester

Project Phase-II - Internal Evaluation of progress in Project work shall be evaluated after 8 weeks for 100 marks by the committee constituted for the purpose by the Head of the Department comprising the guide and senior faculty of the department with HOD as Chairman.

Project Phase-III - Internal Evaluation of Project Demonstration, which shall be evaluated after 15 weeks for 100 marks by the committee constituted for the purpose by the Head of the Department.

Final Evaluation of Project Work and Viva-voce.

Final evaluation of project to be carried out after 16 weeks from the date of commencement of 4^{th} semester.

The Internal Examiner (the project guide with a teaching experience of at least three years) and External Examiner with HOD as chairman will complete the final evaluation of Project.

Internal and External Examiners shall carry out the evaluation for 100 Marks each and the average of these marks shall be the final marks of the Project Evaluation.

Viva – Voce: The Viva-Voce shall be conducted jointly by Internal Examiner and External Examiner with HOD as chairman for 100 Marks.

FRACTURE MECHANICS

Course Code	**:**	**16MMD41**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:

Fracture mechanics provides a methodology for prediction, prevention and control of fracture in materials, components and structures. It provides a background for damage tolerant design. It quantifies toughness as materials resistance to crack propagation.

Course Content: Chapters/ Units

1. **Fracture mechanics principles:** Introduction and historical review, Sources of micro and macro cracks. Stress concentration due to elliptical hole, Strength ideal materials, Griffith's energy balance approach. Fracture mechanics approach to design. NDT and Various NDT methods used in fracture mechanics, Numerical problems. The Airy stress functions. Complex stress function. Solution to crack problems. Effect of finite size. Special cases, Elliptical cracks, Numerical problems. **13 Hours**

2. Plasticity effects, Irwin plastic zone correction. Dugdale approach. The shape of the plastic zone for plane stress and plane strain cases, Plastic constraint factor. The Thickness effect, numerical problems.
   Determination of Stress intensity factors and plane strain fracture toughness: Introduction, analysis and numerical methods, experimental methods, estimation of stress intensity factors. Plane strain fracture toughness test, The Standard test. Size requirements. Non-linearity. Applicability. **13Hours**

3. The energy release rate, Criteria for crack growth. The crack resistance (R curve). Compliance, J integral. Tearing modulus. Stability.
   Elastic plastic fracture mechanics: Fracture beyond general yield. The Crack-tip opening displacement. The Use of CTOD criteria. Experimental determination of CTOD. Parameters affecting the critical CTOD. Use of J integral. Limitation of J integral. **12 Hours**

4. **Dynamics and crack arrest:** Crack speed and kinetic energy. Dynamic stress intensity and elastic energy release rate. Crack branching. Principles of crack arrest. Crack arrest in practice. Dynamic fracture toughness**.** **6 Hours**

5. **Fatigue crack propagation and applications of fracture mechanics:** Crack growth and the stress intensity factor. Factors affecting crack propagation. variable amplitude service loading, means to provide fail-safety, required information for fracture mechanics approach, Mixed mode (combined) loading and design criteria. **8 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. David Broek, “Elementary Engineering Fracture Mechanics”, Springer Netherlands,2011
2. Anderson, “Fracture Mechanics-Fundamental and Application”, T.L CRC press1998.

Reference Books:

1. Karen Hellan, “Introduction to fracture mechanics”, McGraw Hill, 2nd Edition
2. S.A. Meguid, “Engineering fracture mechanics” Elsevier Applied Science, 1989
3. Jayatilaka, “Fracture of Engineering Brittle Materials”, Applied Science Publishers, 1979
4. Rolfe and Barsom, “Fracture and Fatigue Control in Structures”, Prentice Hall, 1977
5. Knott, “Fundamentals of fracture mechanisms”, Butter worth’s, 1973

Course Outcome:

At the end of the course students will:

CO1	Develop fundamental understanding of the effects of crack like defects on the performance of aerospace, civil, and mechanical engineering structures.
CO2	Select appropriate materials for engineering structures to ensure damage tolerance.
CO3	Employ modern numerical methods to determine critical crack sizes and fatigue crack propagation rates in engineering structures.
CO4	Gain appreciation of the status of academic research in field of fracture mechanics.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-3, Chapter-4, Chapter-5, are compulsory, with one question from each chapter
4. Chapter-1 and Chapter-2: two questions to be set with choice.

ELECTIVE-I

COMPUTATIONAL FLUID DYNAMICS

Course Code	**:**	**16MMD421**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:
This course would create awareness about the theory behind fluid dynamics computations as applied in analysis tools.

Course Content: Chapters/ Units

1. Basic Concepts - Dimensionless form of equations; Simplified mathematical models; Hyperbolic, Parabolic & Elliptic systems; Properties of numerical solutions (Consistency, Stability, Conservation, Convergence and Accuracy). **8 Hours**

2. Finite Difference Methods - Discretization; Boundary conditions; error propagation; Introduction to spectral methods; examples. **10 Hours**

3. Finite volume method - Surface & volume integrals; Interpolation & differentiation; Boundary conditions; Examples. **10 Hours**

4. Gaussian Elimination; LU decomposition; Tridiagonal Systems; Iterative methods; convergence; ADI & other splitting methods. Multi-grid method - Coupled equations; Simultaneous solutions, sequential solutions & under relaxation. Nonlinear systems **12 Hours**

5. Initial value problem & Boundary value problems; Implicit & Explicit Schemes; 2D and 3D examples. Heat and Mass transfer Problems; Multi Phase Flows. **12 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. Computational Methods for Fluid Dynamics, 3rd edition - J.H. Ferziger& M. Peric, Springer, 2002.
2. Numerical Solutions of Partial Differential Equations, Finite Difference methods, 3rd ed., - G.D. Smith, Oxford University Press. 1986.

Reference Books:

1. **Computational Fluid Dynamics -** T. J. Chung, Cambridge Univ. Press, 2002.
2. **Partial Differential Equations for Scientists and Engineers -** Farlow, John Wiley, 1982.

Course Outcome:

The student will be able to analyze and obtain numerical solutions to fluid dynamics problems

CO1	The course will equip the students with the necessary knowledge to use computational techniques related to flow mechanics.
CO2	Understand and apply finite difference, finite volume and finite element methods to fluid flow problems
CO3	Understand and apply compressible flow solvers
CO4	Understand the issues surrounding two phase flow modeling

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-1, Chapter-2, Chapter-3, are compulsory, with one question from each chapter
4. Chapter-4 and Chapter-5: two questions to be set with choice.

SMART MATERIALS AND STRUCTURES

Course Code	**:**	**16MMD422**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:
Knowledge of smart materials and structures is essential designing mechanical systems for advanced engineering applications, the course aims at training students in smart materials and structures application and analysis

Course Content: Chapters/ Units

1. **Smart Structures**: Types of Smart Structures, Potential Feasibility of Smart Structures, Key Elements of Smart Structures, Applications of Smart Structures. Piezoelectric materials, Properties, piezoelectric Constitutive Relations, Depoling and Coersive Field, field strain relation. Hysteresis, Creep and Strain Rate effects, Inchworm Linear Motor.

   Beam Modeling: Beam Modeling with induced strain Rate effects, Inchworm Linear Motor Beam Modeling with induced strain Actuation-single Actuators, dual Actuators, Pure Extension, Pure Bending harmonic excitation, Bernoulli-Euler beam Model, problems, Piezoelectric Applications. **12 Hours**

2. **Shape memory Alloy:** Experimental Phenomenology, Shape Memory Effect, Phase Transformation, Tanaka's Constitutive Model, testing of SMA Wires, Vibration Control through SMA, Multiplexing. Applications Of SMA and Problems.

   ER and MR Fluids: Mechanisms and properties, Fluid Composition and behavior, The Bingham Plastic and Related Models, Pre-Yield Response. Post-Yield flow applications in Clutches, Dampers and Others. **14 Hours**

3. **Vibration Absorbers:** series and Parallel Damped Vibrations (Overview), Active Vibration Absorbers, Fiber Optics, Physical Phenomena, Characteristics, Sensors, Fiber Optics in Crack Detection, applications.

   Control of Structures: Modeling, Control Strategies and Limitations, Active Structures in Practice. **14 Hours**

4. **MEMS** – Mechanical Properties of MEMS Materials, Scaling of Mechanical Systems, Fundamentals of Theory, The Intrinsic Characteristics of MEMS, Miniaturization, Microelectronics Integration. **6 Hours**

5. **Devices:** Sensors and Actuators, Conductivity of Semiconductors, Crystal Planes and Orientation, (Stress and Strain Relations, Flexural Beam Bending Analysis Under Simple Loading Conditions), Polymers in MEMS, Optical MEMS Applications. **6 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

TEXT BOOKS:

1. Smart Materials and Structures - M. V. Gandhi and B. So, Thompson, Chapman and Hall, London; New York, 1992 (ISBN: 0412370107).
2. Smart Structures and Materials - B. Culshaw, Artech House, Boston, 1996 (ISBN :0890066817).
3. Smart Structures: Analysis and Design - A. V. Srinivasan, Cambridge University Press, Cambridge; New York, 2001 (ISBN: 0521650267).

REFERENCE BOOKS:

1. Electro ceramics: Materials, Properties and Applications - A. J. Moulson and J. M. Herbert. John Wiley & Sons, ISBN: 0471497429
2. Piezoelectric Sensories: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors. Materials and Amplifiers, Springer, Berlin; New York, 2002 (ISBN: 3540422595).
3. Piezoelectric Actuators and Wtrasonic Motors - K. Uchino, Kluwer Academic Publishers, Boston, 1997 (ISBN: 0792398114).
4. Handbook of Giant Magneto strictive Materials - G. Engdahl, Academic Press, San Diego, Calif.; London, 2000 (ISBN: 012238640X).
5. Shape Memory Materials - K. Otsuka and C. M. Wayman, Cambridge University Press, Cambridge; New York, 199~ (ISBN: 052144487X).

Course Outcome:

At the completion of this course, students will be able to:

CO1	Understand the behavior and applicability of various smart materials.
CO2	Design Simple models for smart structures and materials
CO3	Perform simulation of smart structures and material application.
CO4	Conduct experiments to verify the predictions.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-1, Chapter-4, Chapter-5, are compulsory, with one question from each chapter
4. Chapter-2 and Chapter-3: two questions to be set with choice.

DESIGN OPTIMIZATION

Course Code	**:**	**16MMD423**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:
It aids the students to acquire the basics of optimum design, Classical Optimization Techniques, Non - linear Programming, Unconstrained Optimization Techniques, Integer Programming and Dynamic Programming.

Course Content: Chapters/ Units

Chapters / Units:

1. **Engineering Design Practice:** Evolution of Design Technology, Introduction to Design and the Design Process, Design versus Analysis, Role of Computers in Design Cycle, Impact of CAE on Design, Numerical Modeling with FEA and Correlation with Physical Tests.
   Applications of Optimization in Engineering Design: Automotive, Aerospace and General Industry Applications, Optimization of Metallic and Composite Structures, Minimization and Maximization Problems, MDO and MOO. **10 Hours**

2. **Optimum Design Problem Formulation**: Types of Optimization Problems, The Mathematics of Optimization, Design Variables and Design Constraints, Feasible and Infeasible Designs, Equality and Inequality Constraints, Discrete and Continuous Optimization, Linear and Non-Linear Optimization.
   Optimization Theory – Fundamental Concepts, Global and Local Minimum, Gradient Vector and Hessian Matrix, Concept of Necessary and Sufficient Conditions, Constrained and Unconstrained Problems, Lagrange Multipliers and Kuhn Tucker Conditions. **12 Hours**

3. **Sensitivity Analysis, Linear and** Non-Linear Approximations. Gradient Based Optimization Methods – Dual and Direct.
   Optimization Disciplines: Conceptual Design Optimization and Design Fine Tuning, Combined Optimization, Optimization of Multiple Static and Dynamic Loads, Transient Simulations, Equivalent Static Load Methods. **10 Hours**

4. **Manufacturability in Optimization Problems:** Design for Manufacturing, Manufacturing Methods and Rules, Applying Manufacturing Constraints to Optimization Problems.
   Design Interpretation: Unbound Problems, Over Constrained Problems, Problems with No of Multiple Solutions, Active and Inactive Constraints, Constraint Violations and Constraint Screening, Design Move Limits, Local and Global Optimum. **12 Hours**

5. **Dynamic Programming:** Introduction, Multistage decision processes, Principle of optimality, Computational Procedure in dynamic programming, Initial value problem, Examples. **8 Hours**

Text Books:

1. S.S. Rao, Engineering Optimization: Theory and Practice, John Wiley, 2009
2. JasbirArora, Introduction to Optimum Design, McGraw Hill, 2011.

Reference Books:

1. Optimization and Probability in System Engg - Ram, Van Nostrand.
2. Optimization methods - K. V. Mital and C. Mohan, New age International Publishers, 1999.
3. Optimization methods for Engg. Design - R.L Fox, Addison – Wesley, 1971.

Course Outcome:

At the completion of this course, students will be able to:

CO1	It provides the student with knowledge required to optimize an existing design with single or multiple objective functions.
CO2	Skills acquired through commercial optimization programs
CO3	Acquire the knowledge of engineering system design

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-1, Chapter-3, Chapter-5, are compulsory, with one question from each chapter
4. Chapter-2 and Chapter-4: two questions to be set with choice.

DR AMBEDKAR INSTITUTE OF TECHONOLOGY

DEPARTMENT OF MECHNICAL ENGINEERING

SCHEME AND SYLLABUS

FOR

M.Tech MACHINE DESIGN

YEAR 2017-18

PROGRAM EDUCATIONAL OBJECTIVES

PEO1--Graduates will have knowledge in the discipline of Machine Design with hands on skill in using modern engineering tools to address real world engineering problems and be socially responsible.
PEO2– Graduates shall be successful in their career as analysts and designers of structural components of conventional and advanced materials, participating in a team or individually in an industry, research or academia.
PEO3– Graduates shall be proficient in their communication, presentation and will be prepared to engage in the process of life-long learning through professional development and research.

PROGRAM OUTCOMES

PO No.	Program Outcomes (PO)
PO1	Acquire in-depth knowledge of specific discipline or professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.
PO2	Analyze complex engineering problems critically, apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context
PO3	Think laterally and originally, conceptualize and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.
PO4	Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.
PO5	Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of the limitations.
PO6	Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.
PO7	Demonstrate knowledge and understanding of engineering and management principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economic and financial factors.
PO8	Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.
PO9	Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.
PO10	Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.
PO11	Observe and examine critically the outcomes of one's actions and make corrective

DR AMBEDKAR INSTITUTE OF TECHONOLOGY

M.TECH/ MACHINE DESIGN **CREDIT BASED**

Subject Code	Name of the Subject	I SEMSTER						
		MARKS	CREDITS	L	T	P	S	TOTAL
16MMD11	ADVANCED MECHANICS OF SOLIDS	100	04	4	0	0	0	4
16MMD12	FINITE ELEMENT METHOD	100	04	4	0	0	0	4
16MMD13	ADVANCED DESIGN OF MECHANISM	100	04	4	0	0	0	4
16MMD14	ADVANCED THEORY OF VIBRATIONS	100	04	4	0	0	0	4
16MMD15X	ELECTIVE-I	100	04	4	0	0	0	4
16MMDL16	VIBRATION LAB	100	02	0	0	02	0	2
16MMDS17	TECHNICAL SEMINAR	100	02	0	0	0	02	2
16MMDM18	MINI PROJECT OR INDUSTRIAL VISIT	100	02	0	0	0	02	2
	TOTAL	**800**	**26**	**20**	**00**	**02**	**04**	**26**

ELECTIVE –I

16MMD151 MECHATRONICS SYSTEMS DESIGN

16MMD152 DESIGN FOR MANUFACTURE

16MMD153 AUTOMOBILE SYSTEM DESIGN

Subject Code	Name of the Subject	II SEMSTER						
		MARKS	CREDITS	L	T	P	S	TOTAL
16MMD21	COMPOSITE MATERIAL TECHONOLOGY	100	04	4	0	0	0	4
16MMD22	ADVANCED MACHINE DESIGN	100	04	4	0	0	0	4
16MMD23	EXPERIMENTAL MECHANICS	100	04	4	0	0	0	4
16MMD24	TRIBOLOGY & BEARING DESIGN	100	04	4	0	0	0	4
16MMD25X	ELECTIVE-I	100	04	4	0	0	0	4
16MMDL26	FINITE ELEMENT ANALYSIS LAB	100	02	0	0	02	0	2
RM 27	RESEARCH METHODOLOGY	100	02	0	0	0	02	2
16MMDM28	MINI PROJECT //INDUSTRIAL VISIT/FIELD WORK/TECHNICAL	100	02	02	0	0	0	2
	TOTAL	**800**	**26**	**22**	**00**	**02**	**02**	**26**

ELECTIVE-I

16MMD251 THEORY OF PLASTICITY

16MMD252 ROTOR DYNAMICS

16MMD253 FINITE ELEMENT METHODS FOR HEAT TRANSFER AND FLUID FLOW ANALYSIS

Subject Code	Name of the Subject	III SEMSTER						
		MARKS	**CREDITS**	**L**	**T**	**P**	**S**	**TOTAL**
16MMD31	MIDTERM PRESENTATION ON INTERNSHIP	50	2	0	0	2	0	02
16MMD32	REPORT ON INTERNSHIP	100	13	0	0	13	0	13
16MMD33	EVALUATION AND VIVA-VOCE ON INTERNSHIP	100	05	0	0	05	0	05
16MMD32	PROJECT PHASE-1	50	00	0	0	0	0	PP
	TOTAL	**300**	**20**	**0**	**0**	**20**	**00**	**20**

NOTE: III Semester:

- **Internship**: The student shall undergo internship for 16 weeks.

  Preliminary Report submission and Evaluation after 8th week of Internship to be carried out by the Internal Guide of the college and a senior faculty for 50 marks

  Final report submission and evaluation to be carried out after 16^{th} week of internship by the internal guide of the college and a senior faculty. Report evaluation to be completed within two weeks of submission for 100 marks.

  Viva-Voce on Internship - To be conducted by the Internship Guide (from the college) and the External Guide / Examiner within 2 weeks of Submission with a senior faculty / HOD as chairman for 100 marks

- **Project Phase: I**

  Problem formulation and submission of **synopsis** within 8 weeks from the commencement of 3rd semester, which shall be evaluated for 50 marks by the committee constituted for the purpose by the Head of the Department comprising the guide, senior faculty of the department with HOD as Chairman.

  Literature survey and progress done after 16 weeks shall be evaluated by guide and external examiner with senior faculty / HOD as chairman for 100 marks.

Subject Code	Name of the Subject	IV SEMSTER						
		MARKS	CREDITS	L	T	P	S	TOTAL
16MMD41	FRACTURE MECHANICS	100	04	4	0	0	0	4
16MMD42X	ELECTIVE-I	100	04	4	0	0	0	4
16MMD43	PROJECT PHASE-II	100	02	0	0	0	02	20
16MMD44	PROJECT VIVA- VOCE	200	18	0	0	18	0	
	TOTAL	**500**	**28**	**08**	**00**	**18**	**02**	**28**

ELECTIVE-I

16MMD421 COMPUTATIONAL FLUID DYNAMICS

16MMD422 SMART MATERIALS & STRUCTURES

16MMD423 DESIGN OPTIMIZATION

IV Semester:

- **Project Phase-II -** Internal Evaluation of progress in Project work shall be evaluated after 8 weeks for 100 marks by the committee constituted for the purpose by the Head of the Department comprising the guide and senior faculty of the department with HOD as Chairman.
- **Project Phase-III** - Internal Evaluation of Project Demonstration, which shall be evaluated after 15 weeks for 100 marks by the committee constituted for the purpose by the Head of the Department.
- **Final Evaluation** of Project Work and Viva-voce.
- **Final evaluation** of project to be carried out after 16 weeks from the date of commencement of 4th semester.
- **The Internal Examiner** (the project guide with a teaching experience of at least three years) and External Examiner with HOD as chairman will complete the final evaluation of Project.
- **Internal and External Examiners** shall carry out the evaluation for 100 Marks each and the average of these marks shall be the final marks of the Project Evaluation.
- **Viva – Voce**: The Viva-Voce shall be conducted jointly by Internal Examiner and External Examiner with HOD as chairman for 100 Marks.

ADVANCED MECHANICS OF SOLIDS

Course Code	**:**	**16MMD11**		**CIE Marks**	**:**	**50**
Hrs./Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:

This course aims at a comprehensive study of mechanics of solids. The topics covered are

1. Analysis of stress, strain and stress-strain relations.
2. Solution of plane elasticity problems in rectangular and polar coordinates using analytical methods including thermal loads, body forces and surface tractions
3. Formulation of 3-D boundary value problems
4. Torsion of prismatic bars

Course Content: Chapters/ Units

1. **Introduction:** Definition and notation for forces and stresses. Components of stresses, equations of equilibrium, specification of stress at a point. Principal stresses and Mohr's diagram in 3 dimensions. Boundary conditions, interaction of given surface forces. Strain components, specification of strain at a point compatibility equation.
Stress- strain relation and the general equation of elasticity. Generalized Hooke's law in terms of engineering constant, formulation of elasticity problem. Existence and uniqueness of solution, Saint- Venant's principle. Principle of superposition and reciprocal theorem. **13 Hours**

2. **Plane stress and plane strain problems:** Bending of narrow cantilever beam under end load, simply supported beam with uniform load, use of Fourier series to solve two dimensional problems. Two dimensional problems in polar coordinates. Thin cylinder, pure bending of curved bar, rotating disc and cylinder, bending of curved bar by a force at the end, edge dislocation, effect of circular holes on stress distribution in plates, and vertical load of the straight boundary, forces acting on the end of wedge, stresses in circular disc. Thermal stresses- field equation, stresses in thin disk and long cylinder. 2-D problems in curvilinear coordinates. **13 Hours**

3. Torsion of prismatic bars, membrane analogy, torsion of thin open and closed tubes. **08 Hours**

4. Introduction to pure bending and deflection of plates and shells. **08 Hours**

5. Buckling of struts, stresses and strains in thick curved beam, cylinders and spheres. **08 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

TEXT BOOKS

1. Sadhu Singh, Theory of Elasticity, Khanna publisher
2. Applied elasticity- Wang C.T, Mc Graw Hill book company
3. L S Srinath "Advanced Mechanics of Solids " - Tata McGraw Hill Company.

REFERENCES

1. Theory of elasticity- Timoshenko and Goodier
2. Theory of plates and shells- Timoshenko, Mc Graw Hill book company
3. Dym C. L and Shames. I. H, Solid Mechanics: A variation Approach – McGraw Hill New York-1973.

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO1	Apply basic concepts in continuum mechanics of solids viz. Stress and strain tensors, equilibrium, compatibility and constitutive equations. Mohr's diagram hook's law and methods of solution to elasticity problems, principle of superposition and reciprocal theorem.
CO 2	Study about bending of cantilever beams with different loading condition. Evaluate stresses and displacements in simple solids such as pressurized cylinders, shrink fitted cylinders, rotating disc and shaft, plate with hole and non-circular shafts and thin tubes under torsion.
CO 3	To understand an analyze the Torsion of prismatic bars, membrane analogy, torsion of thin open and closed tubes
CO 4	To understand the stresses developed due to pure bending and deflection of plates and shells.
CO 5	To understand the concepts of Buckling of struts, stresses and strains in thick curved beam, cylinders and spheres.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-3, Chapter-,4 Chapter-5, are compulsory, with one question from each chapter
4. Chapter-1 and Chapter-2: two questions to be set with choice.

FINITE ELEMENT METHOD

Course Code	**:**	**16MMD12**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objectives

1. To present the Finite element method (FEM) as a numerical method for engineering analysis of continua and structures
2. To present Finite element formulation using variational and weighted residual approaches
3. To present Finite elements for the analysis of bars & trusses, beams & frames, plane stress & plane strain problems and 3-D solids, for thermal and dynamics problems.

Course Content: Chapters/ Units

1. **Approximations and round off errors**: Significant figures, accuracy and precision, error definitions, round off errors and truncation errors. Mathematical modeling and Engineering problem solving: Simple mathematical model, Conservation Laws of Engineering**.** **06 Hours**
   System of Linear Algebraic Equations and Eigen Value Problems: Introduction, Direct methods, Cramer's Rule, Gauss Elimination Method, Gauss-Jordan Elimination Method, Triangularization method, Cholesky Method, Partition method, error Analysis for direct methods, Iteration Methods. Eigen values and Eigen Vectors: Bounds on Eigen Values, Jacobi method for symmetric matrices. **06 Hours**

2. **Introduction to Finite Element Method:** Basic Steps in Finite Element Method to solve mechanical engineering (Solid, Fluid and Heat Transfer) problems: Functional approach and Galerkin approach, Displacement Approach: Admissible Functions, Convergence Criteria: Conforming and Non-Conforming elements, C_o C_1 and C_n Continuity Elements. Basic Equations, Element Characteristic Equations, Assembly Procedure, Boundary and Constraint Conditions. **06 Hours**
   Solid Mechanics: One-Dimensional Finite Element Formulations and Analysis – Bars- uniform, varying and stepped cross section-Basic (Linear) and Higher Order Elements Formulations for Axial, Torsional and Temperature Loads with problems. Beams- Basic (Linear) Element Formulation-for uniform, varying and stepped cross section- for different loading and boundary conditions with problems. Trusses, Plane Frames and Space Frame Basic (Linear) Elements Formulations for different boundary condition -Axial, Bending, Torsional, and Temperature Loads with problems. **06 Hours**

3. **Two-Dimensional Finite Element Formulations for Solid Mechanics Problems:** Triangular Membrane (TRIA 3, TRIA 6, TRIA 10) Element, Four-Noded Quadrilateral Membrane (QUAD 4, QUAD 8) Element Formulations for in-plane loading with sample problems.
   Triangular and Quadrilateral, Axis-symmetric basic and higher order Elements formulation for axis-symmetric loading only with sample problems.
   Three-Dimensional Finite Element Formulations for Solid Mechanics Problems: Finite Element Formulation of Tetrahedral Element (TET 4, TET 10), Hexahedral Element (HEXA 8, HEXA 20), for different loading conditions. Serendipity and Lagrange family Elements
   10 Hours

4. **Finite Element Formulations for Structural Mechanics Problems:** Basics of plates and shell theories: Classical thin plate Theory, Shear deformation Theory and Thick Plate theory. Finite Element Formulations for triangular and quadrilateral Plate elements. Finite element formulation of flat, curved, cylindrical and conical Shell elements **08 Hours**
5. **Dynamic Analysis:** Finite Element Formulation for point/lumped mass and distributed masses system, Finite Element Formulation of one-dimensional dynamic analysis: bar, truss, frame and beam element. Finite Element Formulation of Two-dimensional dynamic analysis: triangular membrane and axisymmetric element, quadrilateral membrane and axisymmetric element. Evaluation of eigen values and eigen vectors applicable to bars, shaft, beams, plane and space frame. **10 Hours**

NOTE: students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry.

Text Books:

1. S.S. Sastry, Introductory Methods of Numerical Analysis, PHI, 2005.
2. Steven C. Chapra, Raymond P. Canale, Numerical Methods for Engineers, Tata McGraw Hill, 4^{th} Ed, 2002.
3. M K Jain, S.R.K Iyengar, R K. Jain, Numerical methods for Scientific and engg computation, New Age International, 2003.
4. T. R. Chandrupatla and A. D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall, 3^{rd} Ed, 2002.
5. Lakshminarayana H. V., Finite Elements Analysis– Procedures in Engineering, Universities Press, 2004.

Reference Books:

1. Rao S. S., Finite Elements Method in Engineering- 4^{th} Edition, Elsevier, 2006
2. P. Seshu, Textbook of Finite Element Analysis, PHI, 2004.
3. Bathe K. J., Finite Element Procedures, Prentice-Hall, 2006.
4. Cook R. D., Finite Element Modeling for Stress Analysis, Wiley,1995.
5. David. C. Lay, Linear Algebra and its applications, 3^{rd} edition, Pearson Education, 2002

Course Outcomes:

Upon completion of this course, the students will be able to

CO1	It's important for the students to have basic knowledge about applied mathematics
CO2	Apply basic concepts about developing governing equations by finite element method, Formulate and perform one dimensional,
CO3	Two-dimensional structural analysis using bar, beam, triangular and quadrilateral elements. for Solid Mechanics Problems
CO4	Formulate axisymmetric triangular element and analyze problems on solids of revolution.
CO5	Formulate mass matrices and compute eigen values and eigen vectors for a 1- D and 2D analysis of mechanical system.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-3, Chapter-4, Chapter-5, are compulsory, with one question from each chapter
4. Chapter-1 and Chapter-2: two questions to be set with choice.

ADVANCED DESIGN OF MECHANISM

Course Code	**:**	**16MMD13**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:
To include dynamics considerations in the design of mechanisms for engineering applications is the objective of this course.

Course Content: Chapters/ Units

1. **Geometry of Motion:** Introduction, analysis and synthesis, Mechanism terminology, planar, Spherical and spatial mechanisms, mobility, Grashoffs law, Equivalent mechanisms, Unique mechanisms, Kinematic analysis of plane mechanisms: Auxiliary point method using rotated velocity vector, Hall - Ault auxiliary point method, Goodman's indirect method. **8 Hours**

2. **Generalized Principles of Dynamics:** Fundamental laws of motion, generalized coordinates, Configuration space, Constraints, Virtual work, principle of virtual work, Energy and momentum, Work and kinetic energy, Equilibrium and stability, Kinetic energy of a system, Angular momentum, Generalized momentum. Lagrange's Equation: Lagrange's equation from D'Alembert's principles, Examples, Hamilton's equations, Hamilton's principle, Lagrange's, equation from Hamilton's principle, Derivation of Hamiltons equations, Examples. **13 Hours**

3. **System Dynamics:** Gyroscopic action in machines, Euler's equation of motion, Phase Plane representation, Phase plane Analysis, Response of Linear Systems to transient disturbances. Synthesis of Linkages: Type, number, and dimensional synthesis, Function generation, Path generation and Body guidance, Precision positions, Structural error, Chebyshev spacing, Two position synthesis of slider crank mechanisms, Crank-rocker mechanisms with optimum transmission angle Motion Generation: Poles and relative poles, Location of poles and relative poles, pooled, Curvature, Inflection circle. **13 Hours**

4. Graphical Methods of Dimensional Synthesis: Two position synthesis of crank and rocker mechanisms, three position synthesis, four position synthesis (point precision reduction) Overlay method, Coupler curve synthesis, Cognate linkages. Ana1ytical Methods of Dimensional Synthesis: Freudenstein's equation for four bar mechanism and slider crank mechanism, Examples, Bloch's method of synthesis, Analytical synthesis using complex algebra. **12 Hours**

5. Spatial Mechanisms: Introduction, Position analysis problem, Velocity and acceleration analysis, Eulerian angles. **6 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. Greenwood, "Classical Dynamics", Prentice Hall of India, 1988.
2. K.J. Waldron G.L. Kinzel, "Kinematics, Dynamics and Design of Machinery", Wiley India, 2007.

References Books:

1. J E Shigley, "Theory of Machines and Mechanism" -McGraw-Hill, 1995
2. A.G. Ambekar, "Mechanism and Machine Theory", PHI, 2007.
3. Ghosh and Mallick, "Theory of Mechanism and Mechan ism", East West press 2007.
4. David H. Myszka, "Machines and Mechanisms", Pearson Education, 2005.

Course Outcome:

Upon completion of this course, the student will be able to

CO1	The knowledge of dynamics considerations in mechanism design is essential to use commercial multi body dynamics software in mechanical engineering design.
CO2	Carry out mobility analysis of mechanism and perform velocity and acceleration of complex planer mechanism.
CO3	Synthesize mechanisms for function generation and path generation.
CO4	Analyze the Dynamics of Mechanical systems using D'Alembert's, Lagrange's, and Hamiltons Principles.
CO5	Demonstrate the skills to use software to analyze mechanisms, synthesis of linkages.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-1, Chapter-4, Chapter-5, are compulsory, with one question from each chapter
4. Chapter-2 and Chapter-3: two questions to be set with choice.

ADVANCED THEORY OF VIBRATIONS

Course Code	**:**	**16MMD14**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:

To teach students how to use the theoretical principles of vibration, and vibration analysis techniques, for the practical solution of vibration problems. The course thus builds on student's prior knowledge of vibration theory, and concentrates on the applications. Thus the student will fully understand the importance of vibrations in mechanical design of machine parts that operate in vibratory conditions.

Course Content: Chapters/ Units

1. **Review of Mechanical Vibrations:** Basic concepts; free vibration of single degree of freedom systems with and without damping, forced vibration of single DOF-systems, Natural frequency.
   Transient Vibration of single Degree-of freedom systems: Impulse excitation, Arbitrary excitation, Laplace transform formulation, pulse excitation and rise time, Shock response spectrum, Shock isolation. **10 Hours**

2. **Vibration Control:** Introduction, Vibration isolation theory, Vibration isolation and motion isolation for harmonic excitation, practical aspects of vibration analysis, shock isolation, Dynamic vibration absorbers, Vibration dampers.
   Vibration Measurement and applications: Introduction, Transducers, Vibration pickups, Frequency measuring instruments, Vibration exciters, Signal analysis. **13 Hours**

3. **Modal analysis & Condition Monitoring:** Dynamic Testing of machines and Structures, Experimental Modal analysis, Machine Condition monitoring and diagnosis. Non-Linear Vibrations: Introduction, Sources of nonlinearity, Qualitative analysis of nonlinear systems. Phase plane, Conservative systems, Stability of equilibrium, Method of isoclines, Perturbation method, Method of iteration, Self-excited oscillations. **13 Hours**

4. **Random Vibrations:** Random phenomena, Time averaging and expected value, Frequency response function, Probability distribution, Correlation, Power spectrum and power spectral density, Fourier transforms, FTs and response. **08 Hours**
5. **Continuous Systems:** Vibrating string, longitudinal vibration of rods, Torsional vibration of rods, Euler equation for beams.
   Different methods of vibration dissipation in structural components for general and rotating machinery. **08 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. Theory of Vibration with Application, - William T. Thomson, Marie Dillon Dahleh, Chandramouli Padmanabhan, 5th edition Pearson Education
2. S. Graham Kelly, "Fundamentals of Mechanical Vibration" - McGraw-Hill, 2000
3. S. S. Rao, "Mechanical Vibrations", Pearson Education, 4th edition.

Reference Books:

1. S. Graham Kelly, "Mechanical Vibrations", Schaum's Outlines, Tata McGraw Hill, 2007.
2. C Sujatha, "Vibrations and Acoustics – Measurement s and signal analysis Tata McGraw Hill, 2010

Course Outcome:

Upon completion of this course, the student will be able to

CO1	Model and analyze a free damped, undamped and forced response of a mechanical system.
CO2	Develop equation and analyze the transient response of a single degree freedom system.
CO3	Assess the response characteristics of a continuous mechanical system.
CO4	Analyze and discuss the behavior of single degree freedom system for linear and non-linear behavior.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-1, Chapter-4, Chapter-5, are compulsory, with one question from each chapter
4. Chapter-2 and Chapter-3: two questions to be set with choice.

Elective-I

MECHATRONICS SYSTEMS DESIGN

Course Code	**:**	**16MMD151**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective

1. To educate the student regarding integration of mechanical, electronic, electrical and computer systems in the design of CNC machine tools, Robots etc.
2. To provide students with an understanding of the Mechatronic Design Process, actuators, Sensors, transducers, Signal Conditioning, MEMS and Microsystems and also the Advanced Applications in Mechatronics.

Course Content: Chapters/ Units

1. **Introduction:** Definition and Introduction to Mechatronic Systems. Modeling &Simulation of Physical systems Overview of Mechatronic Products and their functioning, measurement systems. Control Systems, simple Controllers. Study of Sensors and Transducers: Pneumatic and Hydraulic Systems, Mechanical Actuation System, Electrical Actual Systems, Real time interfacing and Hardware components for Mechatronics. **13 Hours**

2. **Electrical Actuation Systems:** Electrical systems, Mechanical switches, Solid state switches, solenoids, DC & AC motors, Stepper motors.
   System Models: Mathematical models: - mechanical system building blocks, electrical system building blocks, thermal system building blocks, electromechanical systems, hydro-mechanical systems, pneumatic systems. **10 Hours**

3. **Signal Conditioning:** Signal conditioning, the operational amplifier, Protection, Filtering, Wheatstone Bridge, Digital signals, Multiplexers, Data Acquisition, Introduction to digital system processing, pulse-modulation.
   MEMS and Microsystems: Introduction, Working Principle, Materials for MEMS and Microsystems, Micro System fabrication process, Overview of Micro Manufacturing, Micro system Design, and Micro system Packaging. **13 Hours**

4. **Data Presentation Systems:** Basic System Models, System Models, Dynamic Response of system. **8 Hours**

5. **Advanced Applications in Mechatronics:** Fault Finding, Design, Arrangements and Practical Case Studies, Design for manufacturing, User-friendly design **8 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. W. Bolton, “Mechatronics” - Addison Wesley Longman Publication, 1999
2. HSU “MEMS and Microsystems design and manufacture”- Tata McGraw-Hill Education, 2002

Reference Books:

1. Kamm, “Understanding Electro-Mechanical Engineering an Introduction to Mechatronics”- IEEE Press, 1 edition ,1996
2. Shetty and Kolk “Mechatronics System Design”- Cengage Learning, 2010
3. Mahalik “Mechatronics”- Tata McGraw-Hill Education, 2003
4. HMT “Mechatronics”- Tata McGraw-Hill Education, 199 8
5. Michel.B. Histand& David. Alciatore, “Introduction to Mechatronics & Measurement Systems”–. Mc Graw Hill, 2002
6. “Fine Mechanics and Precision Instruments”- Pergamon Press, 1971.

Course Outcome:

Upon completion of this course, the student will be able to

CO1	Appreciate multi-disciplinary nature of modern engineering systems.
CO2	Model and analyze mechanical and electrical systems and their connection.
CO3	Be able to integrate mechanical, electronics, control and computer engineering in the design of mechatronics systems.
CO4	Address issues of design, fabrication, and packaging issues of Microsystems.

<u>SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)</u>

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-2, Chapter-4, Chapter-5, are compulsory, with one question from each chapter
4. Chapter-1 and Chapter-3: two questions to be set with choice.

DESIGN FOR MANUFACTURE

Course Code	**:**	**16MMD152**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:

To educate students a clear understanding of factors to be considered in designing parts and components with focus on manufacturability

Course Content: Chapters/ Units

1. **Effect of Materials and Manufacturing Process on Design:** Major phases of design. Effect of material properties on design Effect of manufacturing processes on design. Material selection process- cost per unit property, weighted properties and limits on properties methods.
   Tolerance Analysis: Process capability, mean, variance, skewness, kurtosis, Process capability metrics, Cp, Cpk, Cost aspects, Feature tolerances, Geometries tolerances, Geometric tolerances, Surface finish, Review of relationship between attainable tolerance grades and different machining process. Cumulative effect of tolerance- Sure fit law and truncated normal law.
   13 Hours

2. **Selective Assembly:** Interchangeable part manufacture and selective assembly, Deciding the number of groups -Model-1 : Group tolerance of mating parts equal, Model total and group tolerances of shaft equal. Control of axial play-Introducing secondary machining operations, laminated shims, examples.
   Datum Features: Functional datum, Datum for manufacturing, changing the datum. Examples.
   12 Hours

3. **Design Considerations**: Design of components with casting consideration. Pattern, Mould, and Parting line. Cored holes and machined holes. Identifying the possible and probable parting line. Casting requiring special sand cores. Designing to obviates and cores.
   Component Design: Component design with machining considerations link design for turning components-milling, Drilling and other related processes including finish- machining operations.
   13 Hours
4. True positional theory: Comparison between co-ordinate and convention method of feature location. Tolerance and true position tolerancing virtual size concept, Floating and fixed fasteners. Projected tolerance zone. Assembly with gasket, zero position tolerance. Functional gauges, Paper layout gauging. **7 Hours**

5. Design of Gauges: Design of gauges for checking components in assemble with emphasis on various types of limit gauges for both hole and shaft. **7 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. Harry Peck, “Designing for Manufacturing”, Pitman Publications, 1983.
2. Dieter, “Machine Design” - McGraw-Hill Higher Education, -2008
3. R.K. Jain, “Engineering Metrology", Khanna Publishers, 1986

Reference Books:

1. Product design for manufacture and assembly - Geoffrey Boothroyd, Peter dewhurst, Winston Knight, Merceldekker. Inc. CRC Press, Third Edition
2. Material selection and Design, Vol. 20 - ASM Hand book.

Course Outcomes:

Upon completion of this course, the student will be able to

CO1	Understand the role of manufacture and assembly in development of mechanical parts and their assemblies.
CO2	Apply manufacturing considerations in the design and development of components made of casting and machining.
CO3	Apply geometrical dimensioning and tolerances issues in mechanical design.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

5. Seven FULL questions to be set.
6. Five FULL questions to be answered.
7. Chapter-2, Chapter-4, Chapter-5, are compulsory, with one question from each chapter
8. Chapter-1 and Chapter-3: two questions to be set with choice.

AUTOMOBILE SYSTEM DESIGN

Course Code	**:**	**16MMD153**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:
This course would facilitate understanding of the stages involved in automobile system design. The student will be exposed to industrial practices in design of various systems of an automobile.

Course Content: Chapters/ Units

1. **Body Shapes**: Aerodynamic Shapes, drag forces for small family cars.
Fuel Injection: Spray formation, direct injection for single cylinder engines (both SI & CI), energy audit. **10 Hours**

2. **Design of I.C. Engine** I: Combustion fundamentals, combustion chamber design, cylinder head design for both SI & C. I. Engines. **8 Hours**

3. **Design of I.C. Engine II**: Design of crankshaft, camshaft, connecting rod, piston & piston rings for small family cars (max up to 3cylinders). **12 Hours**

4. **Transmission System**: Design of transmission systems – gearbox (max of 4-speeds), differential.
Suspension System: Vibration fundamentals, vibration analysis (single & two degree of freedom, vibration due to engine unbalance, application to vehicle suspension. **12 Hours**

5. **Cooling System**: Heat exchangers, application to design of cooling system (water cooled).
Emission Control: Common emission control systems, measurement of missions, exhaust gas emission testing. **10 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. **Design of Automotive Engines**, **-** A. Kolchin& V. Demidov, MIR Publishers, Moscow
2. **The motor vehicle, Newton steeds & Garratte -** Ili fee& sons Ltd., London
3. **I.C. Engines -** Edward F Obert, International text book company.

Reference Books:

1. **Introduction to combustion** - Turns
2. **Automobile Mechanic -**, N.K. Giri, Khanna Publications, 1994
3. **I.C. Engines** - Maleev, McGraw Hill book company, 1976
4. **Diesel engine design** – Heldt P.M. Chilton company New York.
5. **Problems on design of machine elements -** V.M. Faires & Wingreen, McMillan Company., 1965
6. **Design of I.C. Engines -** John Heywood, TMH

Course Outcome:

Upon completion of this course, the student will be able to

CO1	The student will be able to apply the knowledge in creating a preliminary design of automobile sub systems.
CO2	Students are exposed to aerodynamic analysis of the auto mobiles.
CO3	Students are exposed to engine performances, combustion analysis and exhaust gas analysis to meet the BIS standards (10000 series).

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-1, Chapter-2, Chapter-5, are compulsory, with one question from each chapter
4. Chapter-3 and Chapter-4: two questions to be set with choice.

Design Engineering Laboratory – Lab 1

Course Code	**:**	**16MMDL16**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 0:0:3**		**SEE Marks**	**:**	**50**
Credits	**:**	**02**		**SEE Duration**	**:**	**3 hours**

Note:
1) These are independent laboratory exercises
2) A student may be given one or two problems stated herein
3) Student must submit a comprehensive report on the problem solved and give a Presentation on the same for Internal Evaluation
4) Any one of the exercises done from the following list has to be asked in the Examination for evaluation.

Course Content:

Experiment #1
Vibration analysis using portable vibration meter with FFT analyzer.

Experiment #2
Modal analysis

Experiment #3
Vibration analysis using accelerometers
- **a)** Uni-axial
- **b)** Tri-axial
- **c)** High temperature Tri-axial

Experiment #4
Vibration Shaker

Experimental #5
Vibration analysis on Beams

Experiment #6
Torsional vibration

Experiment #7
Vibration Characteristics of a Spring Mass Damper System.
Part A: Analytical Solutions.
Part C: Correlation Studies.

Experiment #8
Stress analysis in curved beam in 2D
Part A: Experimental studies using Strain Gauge Instrumentation.
Part B: 2D Photo elastic Investigation.

TECHNICAL SEMINAR

Course Code	**:**	**16MMDS17**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: S 0:0:0:3**		**SEE Marks**	**:**	**50**
Credits	**:**	**02**		**SEE Duration**	**:**	**3 hours**

- **Seminar**: At the end of second CIE each student is required to present the seminar of his/her interested field (Related to design subjects).
- Report submissions and final Evaluation is to be carried out by the Internal Guide of the college and a senior faculty along with HOD.

MINI PROJECT/ INDUSTRIAL VISIT/ FIELD WORK

Course Code	**:**	**16MMDM18**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: S 0:0:0:3**		**SEE Marks**	**:**	**50**
Credits	**:**	**02**		**SEE Duration**	**:**	**3 hours**

- **Industrial Visit**: At the end of second CIE the industrial visit will be arranged in the domain field, each student is required to submit the report of the visit.
- Report submissions and final Evaluation is to be carried out by the Internal Guide of the college and a senior faculty along with HOD.

II Semester

COMPOSITE MATERIALS TECHNOLOGY

Course Code	:	**16MMD21**		**CIE Marks**	:	**50**
Hrs/Week	:	**L: T: P: 4:0:0**		**SEE Marks**	:	**50**
Credits	:	**04**		**SEE Duration**	:	**3 hours**

Course Objective:
Mechanics of composite materials provides a methodology for stress analysis and progressive failure analysis of laminated composite structures for aerospace, automobile, marine and other engineering applications.

Course Content: Chapters/ Units

1. **Introduction to Composite Materials:** Definition, Classification, Types of matrices material and reinforcements, Characteristics &selection, Fiber composites, laminated composites, Particulate composites, Prepegs, and sandwich construction.
   Metal Matrix Composites: Reinforcement materials, Types, Characteristics and selection, Base metals, Selection, Applications
   Macro Mechanics of a Lamina: Hooke's law for different types of materials, Number of elastic constants, Derivation of nine independent constants for orthotropic material, Two - dimensional relationship of compliance and stiffness matrix. Hooke's law for two-dimensional angle lamina, engineering constants - Numerical problems. Invariant properties. Stress-Strain relations for lamina of arbitrary orientation, Numerical problems. **10 Hours**

2. **Micro Mechanical Analysis of a Lamina:** Introduction, Evaluation of the four elastic moduli, Rule of mixture, Numerical problems. Experimental Characterization of Lamina- Elastic Moduli and Strengths
   Failure Criteria: Failure criteria for an elementary composite layer or Ply, Maximum Stress and Strain Criteria, Approximate strength criteria, Inter-laminar Strength, Tsa-Hill theory, Tsai, Wu tensor theory, Numerical problem, practical recommendations. **12 Hours**

3. **Macro Mechanical Analysis of Laminate**: Introduction, code, Kirchoff hypothesis, Classical Lamination Theory, A, B, and D matrices (Detailed derivation), Special cases of laminates, Numerical problems. Shear Deformation Theory, A, B, D and E matrices (Detailed derivation)
   10 Hours

4. **Analysis of Composite Structures:** Optimization of Laminates, composite laminates of uniform strength, application of optimal composite structures, composite pressure vessels, spinning composite disks, composite lattice structures. **8 Hours**

5. **Manufacturing and Testing:** Layup and curing - open and closed Mould processing, Hand lay-up techniques, Bag moulding and filament winding. Pultrusion, Pulforming, Thermoforming, Injection moulding, Cutting, Machining, joining and repair. NDT tests – Purpose, Types of defects, NDT method - Ultrasonic inspection, Radiography, Acoustic emission and Acoustic ultrasonic method.
   Applications: Aircrafts, missiles, Space hardware, automobile, Electrical and Electronics, Marine, Recreational and sports equipment-future potential of composites. **12 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. Autar K. Kaw, Mechanics of Composite materials, CRC Press, 2^{nd} Ed, 2005.
2. Madhijit Mukhopadhay, Mechanics of Composite Materials & Structures, Universities Press, 2004.

Reference Books:

1. J. N. Reddy, Mechanics of Laminated Composite Plates & Shells, CRD Press, 2^{nd} Ed, 2004.
2. Mein Schwartz, Composite Materials handbook, McGraw Hill, 1984.
3. Rober M. Jones, Mechanics of Composite Materials, Taylor & Francis, 1998.
4. Michael W, Hyer, Stress analysis of fiber Reinforced Composite Materials, Mc-Graw Hill International, 2009.
5. Composite Material Science and Engineering, Krishan K. Chawla, Springer, 3e, 2012.
6. Fiber Reinforced Composites, P.C. Mallik, Marcel Decker, 1993.

Course Outcomes:

Upon completion of this course, the student will be able to

CO1	Identify the role of matrices and reinforcements used in practical composite structures.
CO2	Analyze problems on micro and macro mechanical behavior of lamina.
CO3	Assess the strength of laminated composite and predict its failure for given static loading conditions.
CO4	Develop understanding of different methods of manufacturing and testing of composites.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-1, Chapter-3, Chapter-4, are compulsory, with one question from each chapter
4. Chapter-2 and Chapter-5: two questions to be set with choice.

ADVANCED MACHINE DESIGN

Course Code	**:**	**16MMD22**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:
This course enables the student to identify failure modes and evolve design by analysis methodology. Design against fatigue failure is given explicit attention.

Course Content: Chapters/ Units

1. **Introduction:** Role of failure prevention analysis in mechanical design, Modes of mechanical failure, Review of failure theories for ductile and brittle materials including Mohr's theory and modified Mohr's theory, Numerical examples.
   Fatigue of Materials: Introductory concepts, High cycle and low cycle fatigue, Fatigue design models, Fatigue design methods, Fatigue design criteria, Fatigue testing, Test methods and standard test specimens, Fatigue fracture surfaces and macroscopic features, Fatigue mechanisms and microscopic features. **12 Hours**

2. **Stress-Life (S-N) Approach:** S-N curves, Statistical nature of fatigue test data, General S-N behavior, Mean stress effects, Different factors influencing S-N behavior, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using S-N approach.
   Strain-Life(ε-N) approach: Monotonic stress-strain behavior, Strain controlled test methods, Cyclic stress-strain behavior, Strain based approach to life estimation, Determination of strain life fatigue properties, Mean stress effects, Effect of surface finish, Life estimation by ε-N approach.
   13 Hours

3. **LEFM Approach:** LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress effects, Crack growth life estimation. Notches and their effects: Concentrations and gradients in stress and strain, S-N approach for notched membranes, mean stress effects and Haigh diagrams, Notch strain analysis and the strain – life approach, Neuber's rule, Glinka's rule, applications of fracture mechanics to crack growth at notches. **13 Hours**

4. **Fatigue from Variable Amplitude Loading:** Spectrum loads and cumulative damage, Damage quantification and the concepts of damage fraction and accumulation, Cumulative damage theories, Load interaction and sequence effects, Cycle counting methods, Life estimation using stress life approach. **7 Hours**

5. **Surface Failure:** Introduction, Surface geometry, Mating surface, Friction, Adhesive wear, Abrasive wear, Corrosion wear, Surface fatigue spherical contact, cylindrical contact, General contact, Dynamic contact stresses, Surface fatigue strength. **7 Hours**

NOTE: Students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. Ralph I. Stephens, Ali Fatemi, Robert, Henry o. Fuchs, “Metal Fatigue in engineering”, John Wiley New York, Second edition. 2001.
2. Failure of Materials in Mechanical Design, Jack. A. Collins, John Wiley, New York 1992.
3. Robert L. Norton, “Machine Design”, Pearson Education India, 2000

Reference Books:

1. Suresh, “Fatigue of Materials”, Cambridge University Press, -1998
2. Julie. A. Benantine, “Fundamentals of Metal Fatigue Analysis”, Prentice Hall,1990
3. Fatigue and Fracture, ASM Hand Book, Vol 19,2002.

Course Outcomes:

Upon completion of this course, the student will be able to

CO1	Predict failure of engineering components using appropriate failure theories.
CO2	Identify and explain the types of fractures of engineered materials and their characteristic features;
CO3	Estimate life of components using stress life, strain life and LEFM approach.
CO4	Categorize different types of surface failures.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-1, Chapter-4, Chapter-5, are compulsory, with one question from each chapter
4. Chapter-2 and Chapter-3: two questions to be set with choice.

EXPERIMENTAL MECHANICS

Course Code	**:**	**16MMD23**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:

This course aims at a comprehensive study of mechanics of solids. The objective of this course is to familiarize the student with state-of-the-art experimental techniques namely strain gauges, photo elasticity, moiré interferometry, brittle coating, moiré fringes and holography.

Course Content: Chapters/ Units

1. **Introduction**: Definition of terms, calibration, standards, dimension and units, generalized measurement system, Basic concepts in dynamic measurements, system response, distortion, impedance matching, experiment planning.

   Analysis of Experimental Data: Cause and types of experimental errors, error analysis. Statistical analysis of experimental data- Probability distribution, gaussian, normal distribution. Chi-square test, Method of least square, correlation coefficient, multivariable regression, standard deviation of mean, graphical analysis and curve fitting, general consideration in data analysis. **12 Hours**

2. **Data Acquisition and Processing:** General data acquisition system, signal conditioning revisited, data transmission, Analog-to-Digital and Digital-to- Analog conversion, Basic components (storage and display) of data acquisition system. Computer program as a substitute for wired logic.

   Force, Torque and Strain Measurement: Mass balance measurement, Elastic Element for force measurement, torque measurement. Strain Gages -Strain sensitivity of gage metals, Gage construction, Gage sensitivity and gage factor, Performance characteristics, Environmental effects Strain, gage circuits, Potentiometer, Wheat Stone's bridges, Constant current circuits. Strain Analysis Methods-Two element and three element, rectangular and delta rosettes, Correction for transverse strains effects, stress gage - plane shear gage, Stress intensity factor gage. **12 Hours**

3. **Stress Analysis:** Two-Dimensional Photo elasticity **-** Nature of light, - wave theory of light, - optical interference - Polariscopes stress optic law - effect of stressed model in plane and circular Polariscopes, Isoclinic chromatics fringe order determination - Fringe multiplication techniques - Calibration Photo elastic model materials. Separation methods shear difference method, Analytical separation methods, Model to prototype scaling**.** **10 Hours**

4. **Three-Dimensional Photo elasticity:** Stress freezing method, General slice, Effective stresses, Stresses separation, Shear deference method, Oblique incidence method Secondary principals' stresses, Scattered light photo elasticity, Principals, Polari scope and stress data analyses**.** **8 Hours**

5. **Coating Methods:** a) Photo elastic Coating Method-Birefringence coating techniques Sensitivity Reinforcing and thickness effects – data reduction - Stress separation techniques Photo elastic strain gauges. b) Brittle Coatings Method: Brittle coating technique Principles data analysis - coating materials, Coating techniques. c) Moire Technique - Geometrical approach, Displacement approach- sensitivity of Moire data reduction, In plane and out plane Moire methods, Moire photography, Moire grid production.

Holography: Introduction, Equation for plane waves and spherical waves, Intensity, Coherence, Spherical radiator as an object (record process), Hurter, Driffield curves, Reconstruction process, Holographic interferometry, Realtime. and double exposure methods, Displacement measurement, Isopachics. **10 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. **Holman,** "Experimental Methods for Engineers" 7thEdition, Tata McGraw-Hill Companies, Inc, New York, 2007.
2. **R. S. Sirohi, H. C. Radha Krishna,** "Mechanical measurements" New Age International Pvt. Ltd., New Delhi, 2004
3. **Experimental Stress Analysis** - Srinath, Lingaiah, Raghavan, Gargesa, Ramachandra and Pant, Tata McGraw Hill, 1984.
4. **Instrumentation, Measurement and Analysis -**Nakra &Chaudhry, B C Nakra K Chaudhry, Tata McGraw-Hill Companies, Inc, New York, Seventh Edition, 2006.

Reference Books:

1. **Measurement Systems Application and Design -** Doeblin E. A., 4th (S.I.) Edition, McGraw Hill, New York. 1989
2. **Design and Analysis of Experiments -** Montgomery D.C., John Wiley & Sons, 1997.
3. **Experimental Stress Analysis** - Dally and Riley, McGraw Hill, 1991.
4. **Experimental Stress Analysis -** Sadhu Singh, Khanna publisher, 1990.
5. **Photoelasticity Vol I and Vol II -** M.M. Frocht, John Wiley and sons, 1969.
6. **Strain Gauge Primer -** Perry and Lissner, McGraw Hill, 1962.

Course Outcomes:

Upon completion of this course, the student will be able to

CO1	Understand functional requirements of a generalized measurement system and identify suitable components for an application.
CO2	Use concepts of Data Acquisition, Processing and apply the same for interpretation and analysis of experimental data.
CO3	Determine stresses and strains in a structure using different methods such as strain gages, photo-elasticity, brittle coating and holography.
CO4	Identify and apply suitable experimental stress analysis to practical problems

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-3, Chapter-4, Chapter-5, are compulsory, with one question from each chapter
4. Chapter-1 and Chapter-2: two questions to be set with choice.

TRIBOLOGY AND BEARING DESIGN

Course Code	**:**	**16MMD24**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:

Gives in-depth knowledge regarding hydrodynamic, hydrostatic lubrication and various bearings, with their design and applications

Course Content: Chapters/ Units

1. **Introduction to Tribology:** Introduction, Friction, Wear, Wear Characterization, Regimes of lubrication, Classification of contacts, lubrication theories, Effect of pressure and temperature on viscosity. Newton's Law of viscous forces, Flow through stationary parallel plates. Hagen's Poiseuille's theory, viscometers. Numerical problems, Concept of lightly loaded bearings, Petroff's equation, Numerical problems. **8 Hours**

2. **Hydrodynamic Lubrications:** Pressure development mechanism. Converging and diverging films and pressure induced flow. Reynolds's 2D equation with assumptions. Introduction to idealized slide bearing with fixed shoe and Pivoted shoes. Expression for load carrying capacity. Location of center of pressure, effect of end leakage on performance, Numerical problems

   Journal Bearings: Introduction to idealized full journal bearings. Load carrying capacity of idealized full journal bearings, Sommer Feld number and its significance, short and partial bearings, Comparison between lightly loaded and heavily loaded bearings, effects of end leakage on performance, Numerical problems. **12 Hours**

3. **Hydrostatic Bearings:** Hydrostatic thrust bearings, hydrostatic circular pad, annular pad, rectangular pad bearings, types of flow restrictors, expression for discharge, load carrying capacity and condition for minimum power loss, numerical problems, and hydrostatic journal bearings.

   EHL Contacts: Introduction to Elasto- hydrodynamic lubricated bearings. Introduction to 'EHL' constant, Grubin type solution. **12 Hours**

4. **Antifriction bearings:** Advantages, selection, nominal life, static and dynamic load bearing capacity, probability of survival, equivalent load, cubic mean load, bearing mountings.

   Porous Bearings: Introduction to porous and gas lubricated bearings. Governing differential equation for gas lubricated bearings, Equations for porous bearings and working principal, Fretting phenomenon and its stages. **10 Hours**

5. **Magnetic Bearings:** Introduction to magnetic bearings, Active magnetic bearings. Different equations used in magnetic bearings and working principal. Advantages and disadvantages of magnetic bearings, Electrical analogy, Magneto-hydrodynamic bearings.

   Advanced bearing systems and their advantages over conventional bearing systems, testing of different types of bearings **10 hours**

NOTE: Students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books

1. Mujamdar.B.C "Introduction to Tribology of Bearing", Wheeler Publishing, New Delhi 2001
2. Radzimovsky, "Lubrication of Bearings - Theoretical principles and design" Oxford press Company, 2000

Reference Books

1. Dudley D. Fulier " Theory and practice of Lubrication for Engineers", New YorkCompany.1998
2. Moore "Principles and applications of Tribology" Pergamon press, 1975
3. Oscar Pinkus, Beno Sternlicht, “Theory of hydro dynamic lubrication”, McGraw-Hill, 1961
4. G W Stachowiak, A W Batchelor, “Engineering Tribology”, Elsevier publication 1993.
5. Hydrostatic and hybrid bearings, Butterworth 1983.
6. F. M. Stansfield, Hydrostatic bearings for machine tools and similar applications, Machinery Publishing, 1970

Course Outcome:

Upon completion of this course, the student will be able to

CO1	Students develop skills to design and selection of bearings on Various tribological factors to be considered in moving and rotating parts.
CO2	The students are exposed to orient towards the various types of bearings and their applications.
CO3	Students are exposed to synthesis and analysis of the bearings including fault diagnosis.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-1, Chapter-4, Chapter-5, are compulsory, with one question from each chapter
4. Chapter-2 and Chapter-3: two questions to be set with choice.

Elective-II

THEORY OF PLASTICITY

Course Code	**:**	**16MMD251**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:
This course focuses on stress-strain relations, yield criteria and associated flow rules for elastic-plastic analysis of components and structures

Course Content: Chapters/ Units

1. Definition and scope of the subject, Brief review of elasticity, Octahedral normal and shear stresses, Spherical and deviatoric stress, Invariance in terms of the deviatoric stresses, Idealized stress-strain diagrams for different material models, Engineering and natural strains, Mathematical relationships between true stress and true strains, Cubical dilation, finite strains co- efficient Octahedral strain, Strain rate and the strain rate tensor. **11 Hours**

2. Material Models, Stress-strain relations, Yield criteria for ductile metal, Von Mises, Tresca, Yield surface for an Isotropic Plastic materials, Stress space, Experimental verification of Yield criteria, Yield criteria for an anisotropic material, flow rule normality, Yield locus, Symmetry convexity, Deformation of isotropic and kinematic hardening, bilinear stress-strain relationship, power law hardening, deformation theory of plasticity, J2 flow theory, J2incremental theory. **11 Hours**

3. Plastic stress-strain relations, Prandtl-Rouss Saint Venant, Levy-Von Mises, Experimental verification of the Prandtl- Rouss equation Upper and lower bound theorems and corollaries, Application to problems Uni-axial tension and compression, Stages of plastic yielding. **10 Hours**

4. Bending of beams, Torsion of rods and tubes, Nonlinear bending and torsion equations, Simple forms of indentation problems using upper bounds, Application of Metal forming: Extrusion, Drawing, Rolling and Forging. **10 Hours**

5. Slip line theory, Introduction, Basic equations for incompressible two-dimensional flows, continuity equations, Stresses in conditions of plain Strain convention for slip-lines, Geometry of slip lines, Properties of slip lines, Computational Plasticity- Finite element method, Formulations, Plasticity models. **10 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books

1. Engineering Plasticity - Theory and Application to Metal Forming Process -R.A.C..Slater, McMillan Press Ltd., 1977
2. Theory of Plasticity and Metal forming Process - Sadhu Singh, Khanna Publishers, Delhi, 1999.

Reference Books

1. Introduction to the Theory of Plasticity for Engineers- Haffman and Sachs, LLC, 2012.
2. Theory of plasticity - J Chakrabarty, Butterworth, 2006.
3. Plasticity for Mechanical Engineers - Johnson and Mellor, Van Nostrand, 1966.

Course Outcomes:

Upon completion of this course, the student will be able to

CO1	Analyze and determine the elastic and elastoplastic stress- strain behavior of solid deformable bodies subjected to various types of loads.
CO2	Analyze and asses the yielding behavior in metallic material using suitable yield criteria.
CO3	Develop plastic stress-strain relation for large plastic deformation and apply same along with knowledge of yield criteria to various metal forming process.
CO4	Develop fundamental equations of slip line field theory.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-3, Chapter-4, Chapter-5, are compulsory, with one question from each chapter
4. Chapter-1 and Chapter-2: two questions to be set with choice.

ROTOR DYNAMICS

Course Code	**:**	**16MMD252**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:
This course is of interest to turbo machinery designers. Specifically modeling of bearings, shafts and rotor stages (compressors, turbines including blades) to predict instability like whirling including gyroscopic and corialis effect.

Course Content: Chapters/ Units

1. **Fluid Film Lubrication:** Basic theory of fluid film lubrication, Derivation of generalized Reynolds equations, Boundary conditions, Fluid film stiffness and Damping coefficients, Stability and dynamic response for hydrodynamic journal bearing, Two lobe journal bearings.
   Stability of Flexible Shafts: Introduction, equation of motion of a flexible shaft with rigid support, Radial elastic friction forces, Rotary friction, friction Independent of velocity, friction dependent on frequency, Different shaft stiffness Constant, gyroscopic effects, Nonlinear problems of large deformation applied forces, instability of rotors in magnetic field. **14 Hours**

2. **Critical Speed:** Dunkerley's method, Rayleigh's method, Stodola's method. Rotor Bearing System: Instability of rotors due to the effect of hydrodynamic oil layer in the bearings, support flexibility, Simple model with one concentrated mass at the center **6 Hours**

3. **Turbo rotor System Stability by Transfer Matrix Formulation:** General turbo rotor system, development of element transfer matrices, the matrix differential equation, effect of shear and rotary inertia, the elastic rotors supported in bearings, numerical solutions. **10 Hours**

4. **Turbo rotor System Stability by Finite Element Formulation:** General turbo rotor system, generalized forces and co-ordinates system assembly element matrices, Consistent mass matrix formulation, Lumped mass model, linearized model for journal bearings, System dynamic equations Fix stability analysis non dimensional stability analysis, unbalance response and Transient analysis. **14 Hours**

5. **Blade Vibration:** Centrifugal effect, Transfer matrix and Finite element, approaches. **8 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry.

Reference Books:

1. Cameron, “Principles of Lubrication”, Longman Publishing Group, 1986
2. Bolotin, “Nonconservative problems of the Theory of elastic stability”, Macmillan, 1963
3. Peztel, Lockie, “Matrix Methods in Elasto Mechanic s”, McGraw-Hill, 1963.
4. Timoshenko, “Vibration Problems in Engineering”, Ox ford City Press, 2011
5. Zienkiewicz, “The finite element method in engineering science”, McGraw-Hill, 1971

Course Outcomes:

Upon completion of this course, the student will be able to

CO1	Model a rotating machine element theoretically for rotor dynamic analysis.
CO2	Analyze Free and Forced lateral response of simple rotor models and of more complex systems including shafts, bearings, seals and stators.
CO3	Formulate Finite element and carry out analysis for Turborotor System Stability.
CO4	Apply Finite element approach to blade vibration.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-2, Chapter-3, Chapter-5, are compulsory, with one question from each chapter
4. Chapter-1 and Chapter-4: two questions to be set with choice.

FINITE ELEMENT METHODS FOR HEAT TRANSFER AND FLUID FLOW ANALYSIS

Course Code	**:**	**16MMD253**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:
The student will learn finite element formulation of various modes of heat transfer and fluid flow and to solve numerical examples.

Course Content: Chapters/ Units

1. **Introduction to Heat Transfer and Fluid Mechanics:** Mathematical Preliminaries, Governing equations of a continuum, Governing equation in terms of primitive variables, porous equations, low speed compressible flow equations, auxiliary transport equations, chemically reacting systems, boundary conditions, change of phase, enclosure radiation.
2.
Finite Element Methods: Introduction, model differential equation, finite element approximations, interpolation functions, library of finite elements, modeling considerations, assembly of elements, numerical integration, discussion of results with some practical examples, time dependent problems.
12 Hours

2. **Steady State Conduction Heat Transfer:** Introduction, one dimensional linear, quadratic element. Homogeneous, composite wall with uniform and varying cross-sectional area. Radial heat flow in a cylinder. Conduction –convection systems. Numerical examples.
Conduction Heat Transfer: Interpolation functions for tetrahedral, hexahedral, pyramid and prism elements. Numerical integration, computation of surface flux, semi-discrete finite element model, solution of nonlinear equations for transient problems. Radiation algorithms. Variable properties.
12 Hours

3. **Advanced topic in Conduction:** specialty elements, computation of boundary conditions, bulk nodes, reactive materials, material motions Example problems on conduction, radiation, temperature dependent conductivity, anisotropic conduction, brazing and welding, investment casting. **8 Hours**

4. **Flows of Viscous Incompressible Fluids:** Governing equation, mixed finite element model, penalty finite element models. Finite element models of porous flow
Computational consideration: Interpolation functions for triangular, quadrilateral, tetrahedral and hexahedral elements. Evaluation of element matrices in penalty model, pressure calculation and traction boundary conditions. Numerical examples. **10 Hours**

5. **Coupled Fluid Flow and Heat Transfer:** Introduction to non-isothermal incompressible flows, governing equations and boundary condition. Mixed, penalty finite element model. Finite element model for porous flow. Non-isothermal low speed compressible flows: governing equation, boundary conditions, mixed finite element model and solution methods. Convection with change of phase, convection with enclosure radiation, turbulent heat transfer, chemically reacting systems. Numerical examples. **10 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. J N Reddy, David K. Gartling, "The finite element method in heat transfer and flu id dynamics", CRC, 2004.
2. Roland Wynne Lewis, Perumal Nithiarasu, K. N. Seetharamu," Fundamentals of the finite element method for heat and fluid flow"
   John Wiley, 2004

Reference Books:

1. Ching Jen Chen, R. A. Bernatz, "Finite analytic method in flows and heat transfer", Taylor & Francis.
2. Gianni Comini, Stefano Del Giudice, Carlo Nonino, "Finite Element Analysis in Heat Transfer: Basic Formulation and Linear problems" Taylorand Francis, 1994.

Course Outcomes:

Upon completion of this course, the student will be able to

CO1	This course enables the student to use numerical methods for solving problems of fluid flow and heat transfer.
CO2	Analyze of the continuum mechanics problems like fluid flow, heat transfer.
CO3	Analyze of incompressible and compressible fluids.
CO4	Analyze modes of conduction in various mechanical systems

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-3, Chapter-4, Chapter-5, are compulsory, with one question from each chapter
4. Chapter-1 and Chapter-2: two questions to be set with choice.

Design Engineering Laboratory - Lab 2

Course Code	**:**	**16MMDL26**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 0:0:3**		**SEE Marks**	**:**	**50**
Credits	**:**	**02**		**SEE Duration**	**:**	**3 hours**

Note:

1) These are independent laboratory exercises
2) A student may be given one or two problems stated herein
3) Student must submit a comprehensive report on the problem solved and give a Presentation on the same for Internal Evaluation
4) Any one of the exercises done from the following list has to be asked in the Examination for evaluation.

Course Content:

Experiment #1 Structural Analysis
Part A: FE Modeling of a stiffened Panel using a commercial preprocessor.
Part B: Buckling, Bending and Modal analysis of stiffened Panels.
Part C: Parametric Studies.

Experiment #2 Design Optimization
Part A: Shape Optimization of a rotating annular disk.
Part B: Weight Minimization of a Rail Car Suspension Spring.
Part C: Topology Optimization of a Bracket.

Experiment #3 Thermal analysis
Part A: Square Plate with Temperature Prescribed on one edge and Opposite edge insulated.
Part B: A Thick Square Plate with the Top Surface exposed to a Fluid at high temperature, Bottom Surface at room temperature, Lateral Surfaces Insulated.

Experiment #4 Thermal Stress Analysis
Part A: A Thick-Walled Cylinder with specified Temperature at inner and outer Surfaces.
Part B: A Thick-Walled Cylinder filled with a Fluid at high temperature and Outer Surface exposed to atmosphere.

Experiment#5 CFD Analysis
Part A: CFD Analysis of a Hydro Dynamic Bearing using commercial code.
Part B: Comparison of predicted Pressure and Velocity distributions with Target solutions.
Part C: Experimental Investigations using a Journal Bearing Test Rig.
Part D: Correlation Studies.

Experiment #6 Welded Joints.
Part A: Fabrication and Testing.
Part B: FE Modeling and Failure Analysis.
Part C: Correlation Studies.

Experiment #7 Bolted Joints.
Part A: Fabrication and Testing.
Part B: FE Modeling and Failure Analysis.
Part C: Correlation Studies.

Experiment #8 Adhesive Bonded Joints.
Part A: Fabrication and Testing.
Part B: FE Modeling and Failure Analysis.
Part C: Correlation Studies.

RESEARCH METHODOLOGY

Course Code	**:**	**RM 27**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 2:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**02**		**SEE Duration**	**:**	**3 hours**

Course Learning Objectives: Students are expected to

- Have a basic understanding of the underlying principles of quantitative and qualitative research
- Identify the overall process of designing a research study from its inception to its report.
- Choose the most appropriate research method to address a particular research question
- Gain a overview of a range of quantitative and qualitative approaches to data analysis

1. **Overview of Research:** Research and its types, identifying and defining research problem and introduction to different research designs. Essential constituents of Literature Review. Basic principles of experimental design, Primary data and Secondary Data, methods of primary data collection, classification of secondary data, designing questionnaires and schedules. **8 Hours**

2. **Sampling Methods:** Probability sampling: simple random sampling, systematic sampling, stratified sampling, cluster sampling and multistage sampling. Non-probability sampling: convenience sampling, judgment sampling, quota sampling. Sampling distributions. **6 Hours**

3. **Processing and analysis of Data:** Statistical measures and their significance: Central tendencies, variation, skewness, Kurtosis, time series analysis, correlation and regression, Testing of Hypotheses: Parametric (t and Chi Square). **6 Hours**

4. **Essential of Report writing and Ethical issues**: Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Ethical issues related to Research, Plagiarism and self- Plagiarism, Publishing. **6 Hours**

Reference Books:

1. Krishnaswami, K.N., Sivakumar, A. I. and Mathirajan, M., Management Research Methodology, Pearson Education: New Delhi.
2. Kothari C.R., Research Methodology Methods and techniques by, New Age International Publishers, 2nd edition
3. Levin, R.I. and Rubin, D.S., Statistics for Management, 7th Edition, Pearson Education: New Delhi.

Course Outcome:

At the end of the course students will:

CO1	Describe a range of quantitative and qualitative research designs and identify the advantages and disadvantages associated with these designs
CO2	Choose appropriate quantitative or qualitative method to collect data
CO3	Analyze and test the given data using appropriate methods
CO4	Design an appropriate mixed-method research study to answer a research question

MINI PROJECT/ INDUSTRIAL VISIT/ FIELD WORK

Course Code	**:**	**16MMDM28**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: S 0:0:0:3**		**SEE Marks**	**:**	**50**
Credits	**:**	**02**		**SEE Duration**	**:**	**3 hours**

- **Industrial Visit**: At the end of second CIE the industrial visit will be arranged in the domain field, each student is required to submit the report of the visit.
- Report submissions and final Evaluation is to be carried out by the Internal Guide of the college and a senior faculty along with HOD.

OR

- **Seminar**: At the end of second CIE each student is required to present the seminar of his/her interested field (Related to design subjects).
- Report submissions and final Evaluation is to be carried out by the Internal Guide of the college and a senior faculty along with HOD.

Semester III

INTERNSHIP

Internship: The student shall undergo internship for 16 weeks.

Preliminary Report submission and Evaluation after 8th week of Internship to be carried out by the Internal Guide of the college and a senior faculty for 100 marks

Final Report submission and Evaluation after 16th week of Internship to be carried out by the Internal Guide of the college and a senior faculty. Report Evaluation to be completed within two weeks of submission for 100 marks.

Viva-Voce on Internship - To be conducted by the Internship Guide (from the college) and the External Guide / Examiner within 2 weeks of Submission with a senior faculty / HOD as chairman for 100 marks

Project Phase: I

Problem formulation and submission of **synopsis** within 8 weeks from the commencement of 3rd semester, which shall be evaluated for 50 marks by the committee constituted for the purpose by the Head of the Department comprising the guide, senior faculty of the department with HOD as Chairman.

Literature survey and progress done after 16 weeks shall be evaluated by guide and external examiner with senior faculty / HOD as chairman for 100 marks.

IV Semester

Project Phase-II - Internal Evaluation of progress in Project work shall be evaluated after 8 weeks for 100 marks by the committee constituted for the purpose by the Head of the Department comprising the guide and senior faculty of the department with HOD as Chairman.

Project Phase-III - Internal Evaluation of Project Demonstration, which shall be evaluated after 15 weeks for 100 marks by the committee constituted for the purpose by the Head of the Department.

Final Evaluation of Project Work and Viva-voce.

Final evaluation of project to be carried out after 16 weeks from the date of commencement of 4^{th} semester.

The Internal Examiner (the project guide with a teaching experience of at least three years) and External Examiner with HOD as chairman will complete the final evaluation of Project.

Internal and External Examiners shall carry out the evaluation for 100 Marks each and the average of these marks shall be the final marks of the Project Evaluation.

Viva – Voce: The Viva-Voce shall be conducted jointly by Internal Examiner and External Examiner with HOD as chairman for 100 Marks.

FRACTURE MECHANICS

Course Code	**:**	**16MMD41**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:

Fracture mechanics provides a methodology for prediction, prevention and control of fracture in materials, components and structures. It provides a background for damage tolerant design. It quantifies toughness as materials resistance to crack propagation.

Course Content: Chapters/ Units

1. **Fracture mechanics principles:** Introduction and historical review, Sources of micro and macro cracks. Stress concentration due to elliptical hole, Strength ideal materials, Griffith's energy balance approach. Fracture mechanics approach to design. NDT and Various NDT methods used in fracture mechanics, Numerical problems. The Airy stress functions. Complex stress function. Solution to crack problems. Effect of finite size. Special cases, Elliptical cracks, Numerical problems. **13 Hours**

2. Plasticity effects, Irwin plastic zone correction. Dugdale approach. The shape of the plastic zone for plane stress and plane strain cases, Plastic constraint factor. The Thickness effect, numerical problems.
   Determination of Stress intensity factors and plane strain fracture toughness: Introduction, analysis and numerical methods, experimental methods, estimation of stress intensity factors. Plane strain fracture toughness test, The Standard test. Size requirements. Non-linearity. Applicability. **13Hours**

3. The energy release rate, Criteria for crack growth. The crack resistance (R curve). Compliance, J integral. Tearing modulus. Stability.
   Elastic plastic fracture mechanics: Fracture beyond general yield. The Crack-tip opening displacement. The Use of CTOD criteria. Experimental determination of CTOD. Parameters affecting the critical CTOD. Use of J integral. Limitation of J integral. **12 Hours**

4. **Dynamics and crack arrest:** Crack speed and kinetic energy. Dynamic stress intensity and elastic energy release rate. Crack branching. Principles of crack arrest. Crack arrest in practice. Dynamic fracture toughness**.** **6 Hours**

5. **Fatigue crack propagation and applications of fracture mechanics:** Crack growth and the stress intensity factor. Factors affecting crack propagation. variable amplitude service loading, means to provide fail-safety, required information for fracture mechanics approach, Mixed mode (combined) loading and design criteria. **8 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. David Broek, “Elementary Engineering Fracture Mechanics”, Springer Netherlands,2011
2. Anderson, “Fracture Mechanics-Fundamental and Application”, T.L CRC press1998.

Reference Books:

1. Karen Hellan, “Introduction to fracture mechanics”, McGraw Hill, 2nd Edition
2. S.A. Meguid, “Engineering fracture mechanics” Elsevier Applied Science, 1989
3. Jayatilaka, “Fracture of Engineering Brittle Materials”, Applied Science Publishers, 1979
4. Rolfe and Barsom, “Fracture and Fatigue Control in Structures”, Prentice Hall, 1977
5. Knott, “Fundamentals of fracture mechanisms”, Butter worth’s, 1973

Course Outcome:

At the end of the course students will:

CO1	Develop fundamental understanding of the effects of crack like defects on the performance of aerospace, civil, and mechanical engineering structures.
CO2	Select appropriate materials for engineering structures to ensure damage tolerance.
CO3	Employ modern numerical methods to determine critical crack sizes and fatigue crack propagation rates in engineering structures.
CO4	Gain appreciation of the status of academic research in field of fracture mechanics.

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-3, Chapter-4, Chapter-5, are compulsory, with one question from each chapter
4. Chapter-1 and Chapter-2: two questions to be set with choice.

ELECTIVE-I

COMPUTATIONAL FLUID DYNAMICS

Course Code	:	16MMD421		CIE Marks	:	50
Hrs/Week	:	L: T: P: 4:0:0		SEE Marks	:	50
Credits	:	04		SEE Duration	:	3 hours

Course Objective:
This course would create awareness about the theory behind fluid dynamics computations as applied in analysis tools.

Course Content: Chapters/ Units

1. Basic Concepts - Dimensionless form of equations; Simplified mathematical models; Hyperbolic, Parabolic & Elliptic systems; Properties of numerical solutions (Consistency, Stability, Conservation, Convergence and Accuracy). **8 Hours**

2. Finite Difference Methods - Discretization; Boundary conditions; error propagation; Introduction to spectral methods; examples. **10 Hours**

3. Finite volume method - Surface & volume integrals; Interpolation & differentiation; Boundary conditions; Examples. **10 Hours**

4. Gaussian Elimination; LU decomposition; Tridiagonal Systems; Iterative methods; convergence; ADI & other splitting methods. Multi-grid method - Coupled equations; Simultaneous solutions, sequential solutions & under relaxation. Nonlinear systems **12 Hours**

5. Initial value problem & Boundary value problems; Implicit & Explicit Schemes; 2D and 3D examples. Heat and Mass transfer Problems; Multi Phase Flows. **12 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. Computational Methods for Fluid Dynamics, 3rd edition - J.H. Ferziger& M. Peric, Springer, 2002.
2. Numerical Solutions of Partial Differential Equations, Finite Difference methods, 3rd ed., - G.D. Smith, Oxford University Press. 1986.

Reference Books:

1. **Computational Fluid Dynamics -** T. J. Chung, Cambridge Univ. Press, 2002.
2. **Partial Differential Equations for Scientists and Engineers -** Farlow, John Wiley, 1982.

Course Outcome:

The student will be able to analyze and obtain numerical solutions to fluid dynamics problems

CO1	The course will equip the students with the necessary knowledge to use computational techniques related to flow mechanics.
CO2	Understand and apply finite difference, finite volume and finite element methods to fluid flow problems
CO3	Understand and apply compressible flow solvers
CO4	Understand the issues surrounding two phase flow modeling

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-1, Chapter-2, Chapter-3, are compulsory, with one question from each chapter
4. Chapter-4 and Chapter-5: two questions to be set with choice.

SMART MATERIALS AND STRUCTURES

Course Code	**:**	**16MMD422**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:
Knowledge of smart materials and structures is essential designing mechanical systems for advanced engineering applications, the course aims at training students in smart materials and structures application and analysis

Course Content: Chapters/ Units

1. **Smart Structures**: Types of Smart Structures, Potential Feasibility of Smart Structures, Key Elements of Smart Structures, Applications of Smart Structures. Piezoelectric materials, Properties, piezoelectric Constitutive Relations, Depoling and Coersive Field, field strain relation. Hysteresis, Creep and Strain Rate effects, Inchworm Linear Motor.
   Beam Modeling: Beam Modeling with induced strain Rate effects, Inchworm Linear Motor Beam Modeling with induced strain Actuation-single Actuators, dual Actuators, Pure Extension, Pure Bending harmonic excitation, Bernoulli-Euler beam Model, problems, Piezoelectric Applications.
   12 Hours

2. **Shape memory Alloy:** Experimental Phenomenology, Shape Memory Effect, Phase Transformation, Tanaka's Constitutive Model, testing of SMA Wires, Vibration Control through SMA, Multiplexing. Applications Of SMA and Problems.
   ER and MR Fluids: Mechanisms and properties, Fluid Composition and behavior, The Bingham Plastic and Related Models, Pre-Yield Response. Post-Yield flow applications in Clutches, Dampers and Others. **14 Hours**

3. **Vibration Absorbers:** series and Parallel Damped Vibrations (Overview), Active Vibration Absorbers, Fiber Optics, Physical Phenomena, Characteristics, Sensors, Fiber Optics in Crack Detection, applications.
   Control of Structures: Modeling, Control Strategies and Limitations, Active Structures in Practice. **14 Hours**

4. **MEMS** – Mechanical Properties of MEMS Materials, Scaling of Mechanical Systems, Fundamentals of Theory, The Intrinsic Characteristics of MEMS, Miniaturization, Microelectronics Integration. **6 Hours**

5. **Devices:** Sensors and Actuators, Conductivity of Semiconductors, Crystal Planes and Orientation, (Stress and Strain Relations, Flexural Beam Bending Analysis Under Simple Loading Conditions), Polymers in MEMS, Optical MEMS Applications. **6 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

TEXT BOOKS:

1. Smart Materials and Structures - M. V. Gandhi and B. So, Thompson, Chapman and Hall, London; New York, 1992 (ISBN: 0412370107).
2. Smart Structures and Materials - B. Culshaw, Artech House, Boston, 1996 (ISBN :0890066817).
3. Smart Structures: Analysis and Design - A. V. Srinivasan, Cambridge University Press, Cambridge; New York, 2001 (ISBN: 0521650267).

REFERENCE BOOKS:

1. Electro ceramics: Materials, Properties and Applications - A. J. Moulson and J. M. Herbert. John Wiley & Sons, ISBN: 0471497429
2. Piezoelectric Sensories: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors. Materials and Amplifiers, Springer, Berlin; New York, 2002 (ISBN: 3540422595).
3. Piezoelectric Actuators and Wtrasonic Motors - K. Uchino, Kluwer Academic Publishers, Boston, 1997 (ISBN: 0792398114).
4. Handbook of Giant Magneto strictive Materials - G. Engdahl, Academic Press, San Diego, Calif.; London, 2000 (ISBN: 012238640X).
5. Shape Memory Materials - K. Otsuka and C. M. Wayman, Cambridge University Press, Cambridge; New York, 199~ (ISBN: 052144487X).

Course Outcome:

At the completion of this course, students will be able to:

CO1	Understand the behavior and applicability of various smart materials.
CO2	Design Simple models for smart structures and materials
CO3	Perform simulation of smart structures and material application.
CO4	Conduct experiments to verify the predictions.

<u>SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)</u>

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-1, Chapter-4, Chapter-5, are compulsory, with one question from each chapter
4. Chapter-2 and Chapter-3: two questions to be set with choice.

DESIGN OPTIMIZATION

Course Code	:	16MMD423		**CIE Marks**	:	**50**
Hrs/Week	:	**L: T: P: 4:0:0**		**SEE Marks**	:	**50**
Credits	:	**04**		**SEE Duration**	:	**3 hours**

Course Objective:
It aids the students to acquire the basics of optimum design, Classical Optimization Techniques, Non - linear Programming, Unconstrained Optimization Techniques, Integer Programming and Dynamic Programming.

Course Content: Chapters/ Units

Chapters / Units:

1. **Engineering Design Practice:** Evolution of Design Technology, Introduction to Design and the Design Process, Design versus Analysis, Role of Computers in Design Cycle, Impact of CAE on Design, Numerical Modeling with FEA and Correlation with Physical Tests.
   Applications of Optimization in Engineering Design: Automotive, Aerospace and General Industry Applications, Optimization of Metallic and Composite Structures, Minimization and Maximization Problems, MDO and MOO. **10 Hours**

2. **Optimum Design Problem Formulation**: Types of Optimization Problems, The Mathematics of Optimization, Design Variables and Design Constraints, Feasible and Infeasible Designs, Equality and Inequality Constraints, Discrete and Continuous Optimization, Linear and Non-Linear Optimization.
   Optimization Theory – Fundamental Concepts, Global and Local Minimum, Gradient Vector and Hessian Matrix, Concept of Necessary and Sufficient Conditions, Constrained and Unconstrained Problems, Lagrange Multipliers and Kuhn Tucker Conditions. **12 Hours**

3. **Sensitivity Analysis, Linear and** Non-Linear Approximations. Gradient Based Optimization Methods – Dual and Direct.
   Optimization Disciplines: Conceptual Design Optimization and Design Fine Tuning, Combined Optimization, Optimization of Multiple Static and Dynamic Loads, Transient Simulations, Equivalent Static Load Methods. **10 Hours**

4. **Manufacturability in Optimization Problems:** Design for Manufacturing, Manufacturing Methods and Rules, Applying Manufacturing Constraints to Optimization Problems.
   Design Interpretation: Unbound Problems, Over Constrained Problems, Problems with No of Multiple Solutions, Active and Inactive Constraints, Constraint Violations and Constraint Screening, Design Move Limits, Local and Global Optimum. **12 Hours**

5. **Dynamic Programming:** Introduction, Multistage decision processes, Principle of optimality, Computational Procedure in dynamic programming, Initial value problem, Examples. **8 Hours**

Text Books:

1. S.S. Rao, Engineering Optimization: Theory and Practice, John Wiley, 2009
2. JasbirArora, Introduction to Optimum Design, McGraw Hill, 2011.

Reference Books:

1. Optimization and Probability in System Engg - Ram, Van Nostrand.
2. Optimization methods - K. V. Mital and C. Mohan, New age International Publishers, 1999.
3. Optimization methods for Engg. Design - R.L Fox, Addison – Wesley, 1971.

Course Outcome:

At the completion of this course, students will be able to:

CO1	It provides the student with knowledge required to optimize an existing design with single or multiple objective functions.
CO2	Skills acquired through commercial optimization programs
CO3	Acquire the knowledge of engineering system design

SCHEME OF EXAMINATION (QUESTION PAPER PATTERN)

1. Seven FULL questions to be set.
2. Five FULL questions to be answered.
3. Chapter-1, Chapter-3, Chapter-5, are compulsory, with one question from each chapter
4. Chapter-2 and Chapter-4: two questions to be set with choice.

DR AMBEDKAR INSTITUTE OF TECHONOLOGY

DEPARTMENT OF MECHNICAL ENGINEERING

SCHEME AND SYLLABUS

FOR

M. Tech MACHINE DESIGN

YEAR 2018-19

PROGRAM EDUCATIONAL OBJECTIVES

PEO1--Graduates will have knowledge in the discipline of Machine Design with hands on skill in using modern engineering tools to address real world engineering problems and be socially responsible.

PEO2– Graduates shall be successful in their career as analysts and designers of structural components of conventional and advanced materials, participating in a team or individually in an industry, research or academia.

PEO3– Graduates shall be proficient in their communication, presentation and will be prepared to engage in the process of life-long learning through professional development and research.

PROGRAM OUTCOMES

PO No.	Program Outcomes (PO)
PO1	Acquire in-depth knowledge of specific discipline or professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.
PO2	Analyze complex engineering problems critically, apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context
PO3	Think laterally and originally, conceptualize and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.
PO4	Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.
PO5	Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of the limitations.
PO6	Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.
PO7	Demonstrate knowledge and understanding of engineering and management principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economic and financial factors.
PO8	Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.
PO9	Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.
PO10	Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.
PO11	Observe and examine critically the outcomes of one's actions and make corrective

BATCH **2018-19** **MACHINE DESIGN**

FIRST SEMSTER			L	T	P	C
1	18MMD11	ADVANCED MECHANICS OF SOLIDS	4	0	0	4.0
2	18MMD12	FINITE ELEMENT METHOD	3	0	2	4.0
3	18MMD131	EXPERIMENTAL MECHANICS	3	0	2	4.0
4	18MMD132	ROBUST DESIGN	4	0	0	
5	18MMD141	DYNAMICS AND MACHINE DESIGN	4	0	0	4.0
6	18MMD142	DESIGN FOR MANUFACTURE	4	0	0	
7	18MMD151	MECHATRONICS SYSTEM DESIGN	4	0	0	4.0
8	18MMD152	AUTOMOBILE SYSTEM DESIGN	4	0	0	
9	18MMD16	INDUSTRIAL VISIT		0	2	2.0
FIRST SEMESTER END CREDITS						22.0

SECOND SEMSTER			L	T	P	C
1	18MMD21	ADVANCED MACHINE DESIGN	4	0	0	4.0
2	18MMD22	ADVANCED THEORY OF VIBRATIONS	3	0	2	4.0
3	18MMD231	TRIBOLOGY AND BEARING DESIGN	4	0	0	4.0
4	18MMD232	DESIGN OPTIMIZATION	4	0	0	
5	18MMD241	COMPOSITE MATERIALS TECHONOLOGY	4	0	0	4.0
6	18MMD242	FINITE ELEMENT METHODS FOR HEAT TRANSFER	4	0	0	
7	18MMD251	THEORY OF PLASTICITY	4	0	0	4.0
8	18MMD252	ROTOR DYNAMICS	4	0	0	
9	RM27	RESEARCH METHODOLOGY	2	0	0	2.0
SECOND SEMESTER END CREDITS						22.0
FIRST YEAR CREDITS						44.0
CUMULATIVE CREDITS AT END OF 1st YEAR						44.0

BATCH **2018-19** **MACHINE DESIGN**

THIRD SEMSTER			L	T	P	C
1	18MMD31	FRACTURE MECHANICS	3	0	0	3.0
2	18MMD32X	ELECTIVE -1	3	0	0	3.0
3	18MMD33X	ELECTIVE -2	3	0	0	3.0
4	18MMDI34	INTERNSHIP	0	0	6	6.0
5	18MMDL35	MODELING AND ANALYSIS LAB	0	0	2	2.0
6	18MMDS36	TECHNICAL SEMINAR	0	0	1	1.0
7	18MMDP37	PROJECT PHASE -1	0	2	0	2.0
THIRD SEMESTER END CREDITS						20.0

ELECTIVE 1			ELECTIVE-2		
SL.NO	NAME OF THE SUBJECT	Subject code	SL.NO	NAME OF THE SUBJECT	Subject Code
1	SMART MATERIALS AND STRUCTURES	18MMD321	1	COMPUTER APPLICATIONS IN DESIGN	18MMD331
2	STATISTICAL MODELLING& EXPERIMENTAL DESIGN	18MMD322	2	ADVANCE SYSTEM DESIGN	18MMD332
3	OPTIMIZATION TECHNIQUES	18MMD323	3	DESIGN OF HYDRAULICS AND PNEUMATICS	18MMD333
4	THEORY OF PLATES AND SHELLS	18MMD324	4	COMPUTATIONAL METHODS IN ENGINEERING ANALYSIS	18MMD334

FOURTH SEMSTER			L	T	P	C
1	18MMDP41	PROJECT WORK PHASE II – MIDTERM INTERNAL EVALUATION	0	0	2	2.0
2	18MMDP42	PROJECT WORK EVALUATION AND VIVA VOCE	0	0	22	22
FOURTH SEMESTER END CREDITS						24.0
SECOND YEAR CREDITS						44.0
CUMULATIVE CREDITS AT END OF 2nd YEAR						88.0

1ST SEMESTER

ADMISSION YEAR:2018-19 **ACADEMIC YEAR: 2018-19**

COURSE TITLE: ADVANCED MECHANICS OF SOLIDS		
Sub Code:18MMD11	**No of Credits: L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week: 04**
Exam Duration: 3 hours	**CIE Marks: 50**	**Exam Marks: 50**
Pre-requisites	**MOM, DESIGN OF MACHINE ELEMENTS.**	

COURSE OBJECTIVES:

To study the basic concept of stresses, stress distribution, elastic constants when the material is subjected to loading within the elastic limits. Study the stress distribution in plane, polar and cylindrical coordinate systems. Analyze the material or component subjected to torsion of circular and non-circular shafts (elliptical, triangular bars) Study the thermo-elastic properties of the material at elevated temperatures.

#	CONTENTS	Hrs
UNIT-1	**INTRODUCTION TO STRESS:** Definition and Notation for forces and stresses. Components of stresses, equations of Equilibrium, Specification of stress at a point. Principal stresses and shear stresses and Mohr's diagram in three dimensions. Boundary conditions. Stress transformation, Stress components on an arbitrary plane, Stress invariants, Octahedral stresses, Decomposition of state of stress.	08
UNIT-2	**INTRODUCTION TO STRAIN**: Deformation, Strain Displacement relations, Strain components, The state of strain at a point, Principal strain, Strain transformation, Compatibility equations, Cubical dilatation. **STRESS-STRAIN RELATIONS AND THE GENERAL EQUATIONS OF ELASTICITY**: Generalized Hooke's; law in terms of engineering constants. Formulation of elasticity Problems. Existence and uniqueness of solution, Saint -Venant's principle, Principle of super position and reciprocal theorem.	10
UNIT-3	**ENERGY METHODS**: Work done by forces and elastic strain energy stored, Begg’s Deformeter, First theorem of Castigliano, Theorem of virtual work, Kirchhoff’s theorem.	10
UNIT-4	**TWO DIMENSIONAL PROBLEMS IN CARTESIAN CO-ORDINATES:** Airy's stress function, investigation for simple beam problems. Bending of a narrow cantilever beam under end load, simply supported beam with uniform load, Use of Fourier series to solve two dimensional problems. **TORSION OF PRISMATIC BARS:** Torsion of Circular and elliptical cross section bars, Membrane analogy, Torsion of thin-walled closed tubes.	14

UNIT-5	**TWO DIMENSIONAL PROBLEMS IN POLAR CO-ORDINATES:** General equations, stress distribution symmetrical about an axis, thick cylinder, shrink fit, Strain components in polar co-ordinates, Rotating disk and cylinder, Thermal stresses in thin discs, Stress concentration around a circular hole in an infinite plate. Thermo-elastic stress –strain relations.	**14**

TEXT BOOKS:

1. **Advanced Mechanics of solids**, L. S. Srinath, Tata Mc. Graw Hill, 2003
2. **Theory of Elasticity,** S. P. Timoshenko and J. N Gordier, McGraw Hill International, 3rd edition, 1972

REFERENCES BOOKS:

1. **Theory of Elasticity,** Dr. Sadhu Singh, Khanna Publications, 1988
2. **Elasticity, Theory, Applications &Numericals,** Martin H Sadd, Elsevier. 2005
3. **Applied Elasticity,** Seetharaman & Govindaraju, Interline Publishing
4. **Applied Elasticity,** C.T. WANG Sc. D. Mc. Graw Hill Book Co.1953.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)
(Irrespective of portions covered due to whatever might be the reason)

QUESTION PAPER PATTERN (SEE)

Q. No	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**
Unit	**1**		**2**		**3**		**4**		**5**	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO1	Apply basic concepts in continuum mechanics of solids viz. Stress and strain tensors, equilibrium, compatibility and constitutive equations and methods of solution to elasticity problems
CO 2	Evaluate stresses and displacements in simple solids such as pressurized cylinders, shrink fitted cylinders, rotating disc and shaft, plate with hole and non-circular shafts and thin tubes under torsion.
CO 3	Use MATLAB or equivalent software to evaluate and plot particular solutions.
CO 4	Apply the principles of plastic deformation to estimate yielding in simple engineering structures.

CO 5	Apply principles of continuum mechanics to design a structure or component to achieve desired performance under realistic constraints.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	2	2	3	3	2	3	3	1	2
CO2	2	3	3	2	2	1	3	2	3	3	3	2
CO3	3	3	3	2	3	2	3	1	3	2	3	2
CO4	3	3	2	2	3	2	3	1	2	2	3	3

ADMISSION YEAR :2018-19 **ACADEMIC YEAR: 2018-19**

COURSE TITLE:	FINITE ELEMENT METHOD	
Sub Code:18MMD12	No of Credits: L-T-P-SS 3:0:0:1 =4	No. of lecture hours/week: 04
Exam Duration: 3 hours	CIE Marks: 50	Exam Marks: 50
Pre-requisites	Engineering Mechanics, Design of Machine Elements	

COURSE OBJECTIVES:

This course enables the student to identify failure modes and evolve design by analysis methodology. Design against fatigue failure is given explicit attention. **To** impart structures analysis for stress, strain & dynamic loading knowledge. To enable formulation of the design problems into FEA. To comprehend the basic concepts and enhance capabilities for solving complex problems. To introduce the concepts of elastic and static analysis problems.

#	CONTENTS	Hrs
UNIT-1	**MATHEMATICS FOR FEM**: Significant figures, accuracy and precision, error definitions, round off errors and truncation errors. Mathematical modeling. **SYSTEM OF LINEAR ALGEBRAIC EQUATIONS AND EIGEN VALUE PROBLEMS:** Gauss Elimination Method, Gauss-Jordan Elimination Method, Triangularization method, Cholesky Method, Partition method, Iteration Methods. Eigen values and Eigen Vectors: Bounds on Eigen Values, Jacobi method for symmetric matrices.	08
UNIT-2	**Introduction to Finite Element Method:** Basic Steps in Finite Element Method to solve mechanical engineering (Solid, Fluid and Heat Transfer) Galerkin approach, Displacement Approach: Admissible Functions, Convergence Criteria: Conforming and Non-Conforming elements, C_o C_1 and C_n Continuity Elements. Basic Equations, Element Characteristic Equations, Assembly Procedure, Boundary and Constraint Conditions	08
UNIT-3	**Solid Mechanics: One-Dimensional Finite Element Formulations and Analysis** – Bars-uniform, varying and stepped cross section-Basic (Linear) and Higher Order Elements Formulations for Axial, Torsional and Temperature Loads with problems. Beams- Basic (Linear) Element Formulation-for uniform, varying and stepped cross section- for different loading and boundary conditions with problems.	08
UNIT-4	**FINITE ELEMENT FORMULATIONS FOR STRUCTURAL MECHANICS PROBLEMS:** Basics of plates and shell theories: Classical thin plate Theory, Shear deformation Theory and Thick Plate theory. Finite Element Formulations for triangular and quadrilateral Plate elements. Finite element formulation of flat, curved, cylindrical and conical Shell elements **TWO-DIMENSIONAL FINITE ELEMENT FORMULATIONS FOR SOLID MECHANICS PROBLEMS**: Triangular Membrane (TRIA 3, TRIA 6, TRIA 10) Element, Four-Noded Quadrilateral Membrane (QUAD 4, QUAD 8) Element Formulations for in-plane loading with sample problems. Triangular and Quadrilateral, Axis-symmetric basic and higher order Elements formulation for axis-symmetric loading only with sample	14

	problems.	
UNIT-5	**THREE-DIMENSIONAL FINITE ELEMENT FORMULATIONS FOR SOLID MECHANICS PROBLEMS:** Finite Element Formulation of Tetrahedral Element (TET 4, TET 10), Hexahedral Element (HEXA 8, HEXA 20), for different loading conditions. Serendipity and Lagrange family Elements. **DYNAMIC ANALYSIS:** Finite Element Formulation for point/lumped mass and distributed masses system, Finite Element Formulation of one-dimensional dynamic analysis: bar, truss, frame and beam element. Finite Element Formulation of Two-dimensional dynamic analysis: triangular membrane and axisymmetric element, quadrilateral membrane and axisymmetric element. Evaluation of eigen values and eigen vectors applicable to bars, shaft, beams, plane and space frame.	14

Text Books:

1. **S.S. SASTRY**, Introductory Methods of Numerical Analysis, PHI, 2005.
2. **STEVEN C. CHAPRA, RAYMOND P. CANALE**, Numerical Methods for Engineers, Tata McGraw Hill, 4th Ed, 2002.
3. **M K JAIN, S.R.K IYENGAR, R K. JAIN**, Numerical methods for Scientific and engg computation, New Age International, 2003.
4. **T. R. CHANDRUPATLA AND A. D. BELEGUNDU**, Introduction to Finite Elements in Engineering, Prentice Hall, 3rd Ed, 2002.
5. **LAKSHMINARAYANA H. V.**, Finite Elements Analysis– Procedures in Engineering, Universities Press, 2004.

Reference Books:

1. **RAO S. S.**, Finite Elements Method in Engineering- 4th Edition, Elsevier, 2006
2. **P. SESHU**, Textbook of Finite Element Analysis, PHI, 2004.
3. **BATHE K. J**., Finite Element Procedures, Prentice-Hall, 2006.
4. **COOK R. D.**, Finite Element Modeling for Stress Analysis, Wiley,1995.
5. **DAVID. C. LAY**, Linear Algebra and its applications, 3rd edition, Pearson Education, 2002

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (Firs100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**
Unit	**1**		**2**		**3**		**4**		**5**	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.

2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

COURSE OUTCOMES: Learners will able to

CO1	Model some simple mathematical models of physical Applications. Develop governing equation for a mechanical system and apply principles of variation and integral formulation to formulate finite element equations.
CO2	Formulate and perform one dimensional, two-dimensional structural analysis using bar, beam, triangular and quadrilateral elements.
CO3	Formulate axisymmetric triangular element and analyze problems on solids of revolution.
CO4	Formulate mass matrices and compute eigen values and eigen vectors for a 1- D and 2D analysis of mechanical system.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	2	2	3	3	2	3	3	1	2
CO2	2	3	3	2	2	1	3	2	3	3	3	2
CO3	3	3	3	2	3	2	3	1	3	2	3	2
CO4	3	3	2	2	3	2	3	1	2	2	3	3

ADMISSION YEAR :2018-19 **ACADEMIC YEAR: 2018-19**

EXPERIMENTAL MECHANICS

Course Code	**:**	**18MMD131**		**CIE Marks**	**:**	**50**
Hrs./Week	**:**	**L: T: P: 3:1:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:
This course aims at a comprehensive study of mechanics of solids. The objective of this course is to familiarize the student with state-of-the-art experimental techniques namely strain gauges, photo elasticity, moiré interferometry, brittle coating, moiré fringes and holography.

Course Content: Chapters/ Units

1. **Introduction**: Definition of terms, calibration, standards, dimension and units, generalized measurement system, Basic concepts in dynamic measurements, system response, distortion, impedance matching, experiment planning.
   Analysis of Experimental Data: Cause and types of experimental errors, error analysis. Statistical analysis of experimental data- Probability distribution, gaussian, normal distribution. **8 Hours**

2. **Force, Torque and Strain Measurement:** Mass balance measurement, Elastic Element for force measurement, torque measurement. Strain Gages -Strain sensitivity of gage metals, Gage construction, Gage sensitivity and gage factor, Performance characteristics, Environmental effects Strain, gage circuits, Potentiometer, Wheat Stone's bridges, Constant current circuits. Strain Analysis Methods-Two element and three element, rectangular and delta rosettes, Correction for transverse strains effects, stress gage - plane shear gage, Stress intensity factor gage. **8 Hours**

3. **Stress Analysis:** Two-Dimensional Photo elasticity **-** Nature of light, - wave theory of light, - optical interference - Polariscopes stress optic law - effect of stressed model in plane and circular Polariscopes, Isoclinic, isochromatic fringe order determination. Calibration Photo elastic model materials. Model to prototype scaling**.** . **8 Hours**

4. **Three-Dimensional Photo elasticity:** Stress freezing method, General slice, Effective stresses, Stresses separation, Shear deference method, Oblique incidence method Secondary principal stresses, Scattered light photo elasticity, Principals, Polari scope and stress data analyses**.**
   Holography: Introduction, Equation for plane waves and spherical waves, Intensity, Coherence, Spherical radiator as an object (record process), Hurter, Driffield curves, Reconstruction process, Holographic interferometry, Realtime. and double exposure methods, Displacement measurement, Isopaches **14 Hours**

5. **Coating Methods:** a) Photo elastic Coating Method-Birefringence coating techniques Sensitivity Reinforcing and thickness effects - data reduction - Stress separation techniques Photo elastic strain gauges. b) Brittle Coatings Method: Brittle coating technique Principles data analysis - coating materials, Coating techniques. c) Moire Technique - Geometrical approach, Displacement approach-sensitivity of Moire data reduction, In plane and out plane Moire methods, Moire photography, Moire grid production. **14 Hours**

NOTE: the students are advised to prepare the lab report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. **Holman,** "Experimental Methods for Engineers" 7thEdition, Tata McGraw-Hill Companies, Inc, New York, 2007.
2. **R. S. Sirohi, H. C. Radha Krishna,** "Mechanical measurements" New Age International Pvt. Ltd., New Delhi, 2004
3. **Experimental Stress Analysis** - Srinath, Lingaiah, Raghavan, Gargesa, Ramachandra and Pant, Tata McGraw Hill, 1984.
4. **Instrumentation, Measurement and Analysis -**Nakra & Chaudhry, B C Nakra K Chaudhry, Tata McGraw-Hill Companies, Inc, New York, Seventh Edition, 2006.

Reference Books:

1. **Measurement Systems Application and Design -** Doeblin E. A., 4th (S.I.) Edition, McGraw Hill, New York. 1989
2. **Design and Analysis of Experiments -** Montgomery D.C., John Wiley & Sons, 1997.
3. **Experimental Stress Analysis** - Dally and Riley, McGraw Hill, 1991.
4. **Experimental Stress Analysis -** Sadhu Singh, Khanna publisher, 1990.
5. **Photoelasticity Vol I and Vol II -** M.M.Frocht,. John Wiley and sons, 1969.
6. **Strain Gauge Primer -** Perry and Lissner, McGraw Hill, 1962.

Course Outcomes:

Upon completion of this course, the student will be able to

CO1	Understand functional requirements of a generalized measurement system and identify suitable components for an application.
CO2	Use concepts of Data Acquisition, Processing and apply the same for interpretation and analysis of experimental data.
CO3	Determine stresses and strains in a structure using different methods such as strain gages, photo-elasticity, brittle coating and holography.
CO4	Identify and apply suitable experimental stress analysis to practical problems

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (Firs100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Unit	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	2	2	3	3	2	3	3	1	2
CO2	2	3	3	2	2	1	3	2	3	3	3	2
CO3	3	3	3	2	3	2	3	1	3	2	3	2
CO4	3	3	2	2	3	2	3	1	2	2	3	3

ADMISSION YEAR :2018-19 **ACADEMIC YEAR: 2018-19**

ROBUST DESIGN

Sub Code: 18MMD132	**No of Credits: L-T-P-SS 4:0:0:0=4**	**No. of lecture hours/week :04**
Exam Duration: 3 hours	**CIE Marks: 50**	**Exam Marks :50**
Pre-requisites	Mom, Design of Machine Elements**.**	

COURSE OBJECTIVES:
To study the basic concept of stresses, stress distribution, elastic constants when the material is subjected to loading within the elastic limits.

#	CONTENTS	Hrs
UNIT-1	**QUALITY BY EXPERIMENTAL DESIGN**: Quality, western and Taguchi quality philosophy, Elements of cost, Noise factors causes of variation, Quadratic loss function and variation of quadratic loss functions. **ROBUST DESIGN:** Steps in robust design: parameter design and tolerance design, reliability improvement through experiments, illustration through numerical examples.	08
UNIT-2	**EXPERIMENTAL DESIGN:** Classical experiments: factorial experiments, terminology, factors. Levels, Interactions, Treatment combination, randomization, 2-level experimental design for two factors and three factors. 3-level experiment deigns for two factors and three factors, factor effects, factor interactions, Fractional factorial design, Saturated design, Central composite designs, Illustration through numerical examples.	08
UNIT-3	**Measures of Variability:** Measures of variability, Concept of confidence level, Statistical distributions: normal, log normal and Weibull distributions. Hypothesis testing, Probability plots, choice of sample size illustration through numerical examples. Analysis and interpretation of experimental data: Measures of variability, Ranking method, column effect method and plotting method, Analysis of variance (ANOVA), in factorial experiments: YATE's algorithm for ANOVA, Regression analysis, Mathematical models from experimental data, illustration through numerical examples.	08
UNIT-4	**TAGUCHI'S ORTHOGONAL ARRAYS:** Types orthogonal arrays, Selection of standard orthogonal arrays, Linear graphs and interaction assignment, dummy level technique, Compound factor method, modification of linear graphs, Column merging method, branching design, Strategies for constructing orthogonal arrays. Signal to Noise ratio (S-N Ratios) : Evaluation of sensitivity to noise, Signal to noise ratios for static problems, Smaller – the – better types, Nominal – the –better – type, larger – the better – type. Signal to noise ratios for dynamic problems, Illustrations through numerical examples.	14

UNIT-5	**PARAMETER DESIGN AND TOLERANCE DESIGN:** Parameter and tolerance design concepts, Taguchi's inner and outer arrays, Parameter design strategy, Tolerance deign strategy, Illustrations through numerical examples. **RELIABILITY IMPROVEMENT THROUGH ROBUST DESIGN**: Role of S-N ratios in reliability improvement; Case study; illustrating the reliability improvement of routing process of a printed wiring board using robust design concepts .	**14**

Text Books:

1.**Madhav S. Phadake,** "Quality Engineering using Robust Design", Prentice Hall,1989.

2.**Douglas Montgomery,** "Design and analysis of experiment", Willey India Pvt. Ltd.,2007.

3.**Phillip J. Ross, Taguchi**, "Techniques for Quality Engineering" McGraw Hill Int.Ed.,1996.

Reference Books:

1. **Thomas B. Barker,** "Quality by Experimental Design" , Marcel Dekker IncASQC Quality Press,1985.
2. **C.F. Jeff Wu**, ichael Hamada, "Experiments planning, analysis and parameter design optimization", John Wiley Ed., 2002.
3. **W.L. Condra, Marcel Dekker**, "Reliability improvement by Experiments", Marcel Dekker Inc ASQC Quality Press, 1985.

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (Firs100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**
Unit	**1**		**2**		**3**		**4**		**5**	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

COURSE OUTCOMES:

Learners will able to

CO1	Apply Design of Experiments (DOE) techniques to various methods of design.
CO 2	Analyze and evaluate design parameters using different design strategies.
CO 3	Illustrate through numerical examples improvements in design parameters.
CO 4	Perform case studies involving identification of parameters, analysis of experimental data in a robust design.

MAPPING OF COs WITH Pos

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	2	2	3	3	2	3	3	1	2
CO2	2	3	3	2	2	1	3	2	3	3	3	2
CO3	3	3	3	2	3	2	3	1	3	2	3	2
CO4	3	3	2	2	3	2	3	1	2	2	3	3

ADMISSION YEAR :2018-19 **ACADEMIC YEAR: 2018-19**

COURSE TITLE: ADVANCED DESIGN OF MECHANISM		
Sub Code: 18MMD141	**No of Credits: L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week: 04**
Exam Duration: 3 hours	**CIE Marks: 50**	**Exam Marks: 100**
Pre-requisites	**Engineering mechanics, MOM, Material science and metallurgy**	

COURSE OBJECTIVES:

To include dynamics considerations in the design of mechanisms for engineering applications is the objective of this course. To study basic principles of machine design. To acquaint with the concepts of strength design related to various components. To familiarize with use of design data books & various codes of practice. To make conversant with preparation of working drawings based on designs and enable the students to have high ethical standards in terms of team work to be a good design engineer

#	CONTENTS	Hrs
UNIT-1	**GEOMETRY OF MOTION:** Introduction, analysis and synthesis, Mechanism terminology, planar, Spherical and spatial mechanisms, mobility, Grashoffs law, Equivalent mechanisms, Unique mechanisms, Kinematic analysis of plane mechanisms: Auxiliary point method using rotated velocity vector, Hall - Ault auxiliary point method, Goodman's indirect method.	08
UNIT-2	**GENERALIZED PRINCIPLES OF DYNAMICS:** Virtual work, principle of virtual work, Equilibrium and stability, Kinetic energy of a system, Angular momentum, Generalized momentum. Lagrange's Equation: Lagrange's equation from D'Alembert's principles, Examples, Hamilton's equations, Hamilton's principle, Lagrange's, equation from Hamilton's principle, Derivation of Hamilton's equations, Examples.	08
UNIT-3	**SPATIAL MECHANISMS**: Introduction, Position analysis problem, Velocity and acceleration analysis, Eulerian angles.	08
UNIT-4	**SYSTEM DYNAMICS:** Gyroscopic action in machines, Euler's equation of motion, Phase Plane representation, Phase plane Analysis, Response of Linear Systems to transient disturbances. Synthesis of Linkages: Type, number, and dimensional synthesis, Function generation, Path generation and Body guidance, Precision positions, Structural error, Chebyshev spacing, two position synthesis of slider crank mechanisms, Crank-rocker mechanisms with optimum transmission angle Motion Generation: Poles and relative poles, Location of poles and relative poles, pooled, Curvature, Inflection circle.	12
UNIT-5	**GRAPHICAL METHODS OF DIMENSIONAL SYNTHESIS:** Two position synthesis of crank and rocker mechanisms, three position synthesis, four position synthesis (point precision reduction) Overlay method, Coupler curve synthesis, Cognate linkages. Ana1ytical Methods of Dimensional Synthesis: Freudenstein's equation for four bar mechanism and slider crank mechanism, Examples, Bloch's method of synthesis, Analytical synthesis using complex algebra.	12

Text Books:

1. **GREENWOOD,** "Classical Dynamics", Prentice Hall of India, 1988.
2. **K.J. Waldron & G.L. Kinzel, "Kinematics, Dynamics and Design of Machinery",** Wiley India, 2007.

References Books:

1. **J E SHIGLEY**, "Theory of Machines and Mechanism" -McGraw-Hill, 1995
2. **A.G. AMBEKAR,** "Mechanism and Machine Theory", PHI, 2007.
3. **GHOSH AND MALLICK**, "Theory of Mechanism and Mechan ism", East West press 2007.
4. **DAVID H. MYSZKA,** "Machines and Mechanisms", Pearson Education, 2005.

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (Firs100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**
Unit	**1**		**2**		**3**		**4**		**5**	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

<u>COURSE OUTCOMES:</u> Learners will able to

CO1	The knowledge of dynamics considerations in mechanism design is essential to use commercial multi body dynamics software in mechanical engineering design.
CO2	Carry out mobility analysis of mechanism and perform velocity and acceleration of complex planer mechanism.
CO3	Synthesize mechanisms for function generation and path generation.
CO4	Analyze the Dynamics of Mechanical systems using D'Alembert's, Lagrange's, and Hamilton's Principles.
CO5	Demonstrate the skills to use software to analyze mechanisms, synthesis of linkages.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	3	2	2	3	2	3	1	3	3
CO2	2	3	3	2	3	3	3	1	2	3	3	2
CO3	3	3	2	3	3	3	1	3	3	2	3	2
CO4	3	3	2	3	3	2	3	2	1	2	3	3

ADMISSION YEAR :2018-19 **ACADEMIC YEAR: 2018-19**

COURSE TITLE: DESIGN FOR MANUFACTURE		
Sub Code: 18MMD142	**No of Credits: L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week: 04**
Exam Duration: 3 hours	**CIE Marks: 50**	**Exam Marks: 50**
Pre-requisites	**metrology & Measurements, Design Of Machine Elements.**	

COURSE OBJECTIVES:

To educate students a clear understanding of factors to be considered in designing parts and components with focus on manufacturability**.** To study Effect of material properties on mechanical design. To acquaint with the concepts of Tolerance. To Design the components with casting consideration. Emphasis on various types of limit gauges for both hole and shaft.

#	CONTENTS	Hrs
UNIT-1	**EFFECT OF MATERIALS AND MANUFACTURING PROCESS ON DESIGN:** Major phases of design. Effect of material properties on design, Effect of manufacturing processes on design. Material selection process cost per unit property, Weighted properties and limits on properties methods.	08
UNIT-2	**TRUE POSITIONAL THEORY:** Comparison between co-ordinate and convention method of feature location. Tolerance and true positioning tolerance virtual size concept, Floating and fixed fasteners. Projected tolerance zone. Assembly with gasket, zero position tolerance. Functional gauges, Paper layout gauging.	10
UNIT-3	**SELECTIVE ASSEMBLY:** interchangeable part manufacture and selective assembly, deciding the number of groups -model-1: group tolerance of mating parts equal, model total and group tolerances of shaft equal. control of axial play-introducing secondary machining operations, laminated shims, examples. Datum features: functional datum, datum for manufacturing, changing the datum. examples	10
UNIT-4	**DESIGN CONSIDERATIONS:** Design of components with casting consideration. Pattern, Mould, and Parting line. Cored holes and Machined holes. Identifying the possible and probable parting line. Casting requiring special sand cores. Designing to obviate sand cores. Component Design: Component design with machining considerations link design for turning components-milling, Drilling and other related processes including finish-machining operations.	12
UNIT-5	**Design of Gauges:** Design of gauges for checking components in assemble with emphasis on various types of limit gauges for both hole and shaft. **TOLERANCE ANALYSIS:** Process capability, mean, variance, skewness, kurtosis, Process capability metrics, Cp, Cpk, Cost aspects, Feature tolerances, Geometries tolerances, Geometric tolerances, Surface finish, Review of relationship between attainable tolerance grades and different machining process. Cumulative effect of tolerance- Sure fit law and truncated normal law.	12

Text Books:

1**. HARRY PECK**, “Designing for Manufacturing”, Pitman Publications, 1983.

2. **DIETER,** "Machine Design" - McGraw-Hill Higher Education, -2008.

3. **R.K. JAIN**, "Engineering Metrology", Khanna Publishers, 1986.

4. **GEOFFREY BOOTHROYD, PETER DEWHURST, WINSTON KNIGHT**, "Product design for manufacture and assembly", Merce Dekker. Inc. CRC Press, Third Edition

5. **MATERIAL SELECTION AND DESIGN**, Vol. 20 - ASM Hand book.

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (First100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**
Unit	**1**		**2**		**3**		**4**		**5**	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

COURSE OUTCOMES:

Upon completion of this course, the student will be able to

CO1	Understand the role of manufacture and assembly in development of mechanical parts and their assemblies.
CO2	Apply manufacturing considerations in the design and development of components made of casting and machining.
CO3	Apply geometrical dimensioning and tolerances issues in mechanical design.

MAPPING OF COs WITH POs

COs/POs	**po1**	**po2**	**po3**	**po4**	**po5**	**po6**	**po7**	**po8**	**po9**	**po10**	**po11**	**po12**
CO1	3	3	3	3	2	2	3	2	3	1	3	3
CO2	2	3	3	2	3	3	3	1	2	3	3	2
CO3	3	3	2	3	3	3	1	3	3	2	3	2
CO4	3	3	2	3	3	2	3	2	1	2	3	3

ADMISSION YEAR :2018-19 **ACADEMIC YEAR: 2018-19**

COURSE TITLE: MECHATRONICS SYSTEMS DESIGN		
Sub Code: 18MMD151	**No of Credits: L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week: 04**
Exam Duration: 3 hours	**CIE Marks: 50**	**Exam Marks: 50**
Pre-requisites	BASIC ELECTRONICS, BASIC ELECTRICALS, MATERIAL SCIENCE AND METROLOGY	

COURSE OBJECTIVES:

To educate the student regarding integration of mechanical, electronic, electrical and computer systems in the design of CNC machine tools, Robots etc. To provide students with an understanding of the Mechatronic Design Process, actuators, Sensors, transducers, Signal Conditioning, MEMS and Microsystems and also the Advanced Applications in Mechatronics

#	CONTENTS	Hrs
UNIT-1	**Introduction:** Definition and Introduction to Mechatronic Systems. Modeling &Simulation of Physical systems Overview of Mechatronic Products and their functioning, measurement systems. Control Systems, simple Controllers.	08
UNIT-2	**Study of Sensors and Transducers:** Pneumatic and Hydraulic Systems, Mechanical Actuation System, Electrical Actual Systems, Real time interfacing and Hardware components for Mechatronics.	08
UNIT-3	**Electrical Actuation Systems:** Electrical systems, Mechanical switches, Solid state switches, solenoids, DC & AC motors, Stepper motors. **System Models:** Mathematical models: - mechanical system building blocks, electrical system building blocks, thermal system building blocks, electromechanical systems, hydro-mechanical systems, pneumatic systems.	08
UNIT-4	**Signal Conditioning:** Signal conditioning, the operational amplifier, Protection, Filtering, Wheatstone Bridge, Digital signals, Multiplexers, Data Acquisition, Introduction to digital system processing, pulse-modulation. **MEMS and Microsystems:** Introduction, Working Principle, Materials for MEMS and Microsystems, Micro System fabrication process, Overview of Micro Manufacturing, Micro system Design, and Micro system Packaging.	14
UNIT-5	**Data Presentation Systems:** Basic System Models, System Models, Dynamic Response of system. **Advanced Applications in Mechatronics:** Fault Finding, Design, Arrangements and Practical Case Studies, Design for manufacturing, User-friendly design	14

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. W. Bolton, "Mechatronics" - Addison Wesley Longman Publication, 1999
2. HSU "MEMS and Microsystems design and manufacture"- Tata McGraw-Hill Education, 2002

Reference Books:

1. Kamm, "Understanding Electro-Mechanical Engineering an Introduction to Mechatronics"- IEEE Press, 1 edition ,1996
2. Shetty and Kolk "Mechatronics System Design"- Cengage Learning, 2010
3. Mahalik "Mechatronics"- Tata McGraw-Hill Education, 2003
4. HMT "Mechatronics"- Tata McGraw-Hill Education, 199 8
5. Michel.B. Histand& David. Alciatore, "Introduction to Mechatronics & Measurement Systems"–. Mc Graw Hill, 2002
6. "Fine Mechanics and Precision Instruments"- Pergamon Press, 1971.

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (First100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Unit	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

Course Outcome:

At the completion of this course, students will be able to:

CO1	Appreciate multi-disciplinary nature of modern engineering systems.
CO2	Model and analyze mechanical and electrical systems and their connection.
CO3	Be able to integrate mechanical, electronics, control and computer engineering in the design of mechatronics systems.
CO4	Address issues of design, fabrication, and packaging issues of Microsystems.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	3	2	2	3	2	3	1	3	3
CO2	2	3	3	2	3	3	3	1	2	3	3	2
CO3	3	3	2	3	3	3	1	3	3	2	3	2
CO4	3	3	2	3	3	2	3	2	1	2	3	3

AUTOMOBILE SYSTEM DESIGN

Course Code	**:**	**18MMD152**		**CIE Marks**	**:**	**50**
Hrs./Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:
This course would facilitate understanding of the stages involved in automobile system design. The student will be exposed to industrial practices in design of various systems of an automobile.

Course Content: Chapters/ Units

1. **Body Shapes**: Aerodynamic Shapes, drag forces for small family cars.
   Fuel Injection: Spray formation, direct injection for single cylinder engines (both SI & CI), energy audit. **08 Hours**

2. **Design of I.C. Engine** I: Combustion fundamentals, combustion chamber design, cylinder head design for both SI & C. I. Engines. 0**8 Hours**

3. **Design of I.C. Engine II**: Design of crankshaft, camshaft, connecting rod, piston & piston rings for small family cars (max up to 3cylinders). 08 **Hours**

4. **Transmission System**: Design of transmission systems – gearbox (max of 4-speeds), differential.
   Suspension System: Vibration fundamentals, vibration analysis (single & two degree of freedom, vibration due to engine unbalance, application to vehicle suspension. **14 Hours**

5. **Cooling System**: Heat exchangers, application to design of cooling system (water cooled).
Emission Control: Common emission control systems, measurement of missions, exhaust gas emission testing. **14 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. **Design of Automotive Engines**, **-** A. Kolchin& V. Demidov, MIR Publishers, Moscow
2. **The motor vehicle, Newton steeds &Garratte -** Iliffee& sons Ltd., London
3. **I.C. Engines -** Edward F Obert, International text book company.

Reference Books:

1. **Introduction to combustion** - Turns
2. **Automobile Mechanic -**, N.K. Giri, Khanna Publications, 1994
3. **I.C. Engines** - Maleev, McGraw Hill book company, 1976
4. **Diesel engine design** – Heldt P.M., Chilton company New York.
5. **Problems on design of machine elements -** V.M. Faires & Wingreen, McMillan Company., 1965
6. **Design of I.C. Engines -** John Heywood, TMH

Course Outcome:

Upon completion of this course, the student will be able to

CO1	The student will be able to apply the knowledge in creating a preliminary design of automobile sub systems.
CO2	Students are exposed to aerodynamic analysis of the auto mobiles.
CO3	Students are exposed to engine performances, combustion analysis and exhaust gas analysis to meet the BIS standards (10000 series).

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (First100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Unit	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

INDUSTRIAL VISIT

Course Code	**:**	**18MMDM16**		**CIE Marks**	**:**	**50**
Hrs./Week	**:**	**L: T: P: S 0:0:0:3**		**SEE Marks**	**:**	**50**
Credits	**:**	**02**		**SEE Duration**	**:**	**3 hours**

- **Industrial Visit**: At the end of second CIE the industrial visit will be arranged in the domain field, each student is required to submit the report of the visit.
- Report submissions and final Evaluation is to be carried out by the Internal Guide of the college and a senior faculty along with HOD.

II Semester

ADMISSION YEAR :2018-19 **ACADEMIC YEAR: 2018-19**

COURSE TITLE:	ADVANCED MACHINE DESIGN	
Sub Code: 18MMD21	**No of Credits: L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week: 04**
Exam Duration: 3 hours	**CIE Marks: 50**	**Exam Marks: 50**
Pre-requisites	**Engineering Mechanics, MoM, Design of Machine Elements**	

COURSE OBJECTIVES:

To study Role of failure prevention analysis in mechanical design. To acquaint with the concepts of damage fraction and accumulation in various damage theories. To study Role of surface failure in mechanical design. Enable the students to have high ethical standards in terms of team work to be a good design engineer.

#	CONTENTS	Hrs
UNIT-1	**INTRODUCTION:** Role of failure prevention analysis in mechanical design, Modes of mechanical failure, Review of failure theories for ductile and brittle materials including Mohr's theory and modified Mohr's theory, Numerical examples. **FATIGUE OF MATERIALS:** Introductory concepts, High cycle and low cycle fatigue, Fatigue design models, Fatigue design methods, Fatigue design criteria, Fatigue testing, Test methods and standard test specimens.	08
UNIT-2	**FATIGUE FROM VARIABLE AMPLITUDE LOADING:** Spectrum loads and cumulative damage, Damage quantification and the concepts of damage fraction and accumulation, Cumulative damage theories, Load interaction and sequence effects, Cycle counting methods, Life estimation using stress life approach.	08
UNIT-3	**SURFACE FAILURE:** Introduction, Surface geometry, Mating surface, Friction, Adhesive wear, Abrasive wear, Corrosion wear, Surface fatigue spherical contact, cylindrical contact, General contact, Dynamic contact stresses, Surface fatigue strength	08
UNIT-4	**STESS-LIFE (S-N) APPROACH:** S-N curves, Statistical nature of fatigue test data, General S-N behavior, Mean stress effects, Different factors influencing S-N behavior, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using S-N approach. **STRAIN-LIFE(E-N) APPROACH:** Monotonic stress-strain behavior, Strain controlled test methods, Cyclic stress-strain behavior, Strain based approach to life estimation, Determination of strain life fatigue properties, Mean stress effects, Effect of surface finish, Life estimation by ε-N approach.	14

UNIT-5	**LEFM APPROACH:** LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress effects, Crack growth life estimation. Notches and their effects: Concentrations and gradients in stress and strain, S-N approach for notched membranes, mean stress effects and Haigh diagrams, Notch strain analysis and the strain – life approach, Neuber's rule, Glinka's rule, applications of fracture mechanics to crack growth at notches.	14

Text Books:

1. **Ralph I. Stephens, Ali Fatemi, Robert, Henry o. Fuchs,** "Metal Fatigue in engineering", John Wiley New York, Second edition. 2001.
2. **Failure of Materials in Mechanical Design**, Jack. A. Collins, John Wiley, New York 1992.
3. **Robert L. Norton, "Machine Design",** Pearson Education India, 2000

Reference Books:

1. **S. Suresh, "Fatigue of Materials"**, Cambridge University Press, -1998
2. **Julie. A. Benantine,** "Fundamentals of Metal Fatigue Analysis", Prentice Hall,1990
3. **Fatigue and Fracture**, ASM Hand Book, Vol 19,2002.

SYLLABUS COVERAGE FOR CIE-1, 2, 3
CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (First100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**
Unit	**1**		**2**		**3**		**4**		**5**	

SCHEME OF EXAMINATION (SEE)
1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

COURSE OUTCOMES:

Learners will able to

CO1	Predict failure of engineering components using appropriate failure theories.

CO2	Identify and explain the types of fractures of engineered materials and their characteristic features;
CO3	Estimate life of components using stress life, strain life and LEFM approach.
CO4	Categorize different types of surface failures.

MAPPING OF COs WITH POs

COs/POs	**po1**	**po2**	**po3**	**po4**	**po5**	**po6**	**po7**	**po8**	**po9**	**po10**	**po11**	**po12**
CO1	3	3	3	3	2	2	3	2	3	1	3	3
CO2	2	3	3	2	3	3	3	1	2	3	3	2
CO3	3	3	2	3	3	3	1	3	3	2	3	2
CO4	3	3	2	3	3	2	3	2	1	2	3	3

ADVANCED THEORY OF VIBRATIONS

Course Code	**:**	**18MMD22**		**CIE Marks**	**:**	**50**
Hrs./Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:

To teach students how to use the theoretical principles of vibration, and vibration analysis techniques, for the practical solution of vibration problems. The course thus builds on student's prior knowledge of vibration theory, and concentrates on the applications. Thus, the student will fully understand the importance of vibrations in mechanical design of machine parts that operate in vibratory conditions.

Course Content: Chapters/ Units

1. **Review of Mechanical Vibrations:** Basic concepts; free vibration of single degree of freedom systems with and without damping, forced vibration of single DOF-systems, Natural frequency.
   Transient Vibration of single Degree-of freedom systems: Impulse excitation, Arbitrary excitation, Laplace transform formulation, pulse excitation and rise time, Shock response spectrum, Shock isolation. **08 Hours**

2. **Vibration Control:** Introduction, Vibration isolation theory, Vibration isolation and motion isolation for harmonic excitation, practical aspects of vibration analysis, shock isolation, Dynamic vibration absorbers, Vibration dampers.
   Vibration Measurement and applications: Introduction, Transducers, Vibration pickups, Frequency measuring instruments, Vibration exciters, Signal analysis. **08 Hours**

3. **Random Vibrations:** Random phenomena, Time averaging and expected value, Frequency response function, Probability distribution, Correlation, Power spectrum and power spectral density, Fourier transforms, FTs and response. **08 Hours**

4. **Modal analysis & Condition Monitoring:** Dynamic Testing of machines and Structures, Experimental Modal analysis, Machine Condition monitoring and diagnosis. Non-Linear Vibrations: Introduction, Sources of nonlinearity, Qualitative analysis of nonlinear systems. Phase plane, Conservative systems, Stability of equilibrium, Method of isoclines, Perturbation method, Method of iteration, Self-excited oscillations. **14 Hours**

5. **Continuous Systems:** Vibrating string, longitudinal vibration of rods, Torsional vibration of rods, Euler equation for beams.
   Different methods of vibration dissipation in structural components for general and rotating machinery. **14 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. Theory of Vibration with Application, - William T. Thomson, Marie Dillon Dahleh, Chandramouli Padmanabhan, 5th edition Pearson Education
2. S. Graham Kelly, “Fundamentals of Mechanical Vibration” - McGraw-Hill, 2000
3. S. S. Rao, “Mechanical Vibrations”, Pearson Education, 4^{th} edition.

Reference Books:

1. S. Graham Kelly, “Mechanical Vibrations”, Schaum’s Outlines, Tata McGraw Hill, 2007.
2. C Sujatha, “Vibrations and Acoustics – Measurement s and signal analysis Tata McGraw Hill, 2010

Course Outcome:

Upon completion of this course, the student will be able to

CO1	Model and analyze a free damped, undamped and forced response of a mechanical system.
CO2	Develop equation and analyze the transient response of a single degree freedom system.
CO3	Assess the response characteristics of a continuous mechanical system.
CO4	Analyze and discuss the behavior of single degree freedom system for linear and non-linear behavior.

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (First100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**
Unit	**1**		**2**		**3**		**4**		**5**	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	3	2	2	3	2	3	1	3	3
CO2	2	3	3	2	3	3	3	1	2	3	3	2
CO3	3	3	2	3	3	3	1	3	3	2	3	2
CO4	3	3	2	3	3	2	3	2	1	2	3	3

TRIBOLOGY AND BEARING DESIGN

Course Code	**:**	**18MMD231**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:

To educate students a clear understanding of factors to be considered in designing parts and components with focus on manufacturability.to study various regimes of lubrication. To acquaint with the concepts of pours and gas lubricated bearings. To study advanced bearing systems and their advantages over conventional bearing systems. Emphasis on various types of bearing systems.

1. **Introduction to Tribology:** Introduction, Friction, Wear, Wear Characterization, Regimes of lubrication, Classification of contacts, lubrication theories, Effect of pressure and temperature on viscosity. Newton's Law of viscous forces, Flow through stationary parallel plates. Hagen's Poiseuille's theory, viscometers. Numerical problems, Concept of lightly loaded bearings, Petroff's equation, Numerical problems. **8 Hours**

2. **Antifriction bearings:** Advantages, selection, nominal life, static and dynamic load bearing capacity, probability of survival, equivalent load, cubic mean load, bearing mountings.
   Porous Bearings: Introduction to porous and gas lubricated bearings. Governing differential equation for gas lubricated bearings, Equations for porous bearings and working principal, Fretting phenomenon and its stages. **08 Hours**

3. **Magnetic Bearings:** Introduction to magnetic bearings, Active magnetic bearings. Different equations used in magnetic bearings and working principal. Advantages and disadvantages of magnetic bearings, Electrical analogy, Magneto-hydrodynamic bearings.
   Advanced bearing systems and their advantages over conventional bearing systems, testing of different types of bearings **08 hours**

4. **Hydrodynamic Lubrications:** Pressure development mechanism. Converging and diverging films and pressure induced flow. Reynolds's 2D equation with assumptions. Introduction to idealized slide bearing with fixed shoe and Pivoted shoes. Expression for load carrying capacity. Location of center of pressure, effect of end leakage on performance, Numerical problems
   Journal Bearings: Introduction to idealized full journal bearings. Load carrying capacity of idealized full journal bearings, Sommer Feld number and its significance, short and partial bearings, Comparison between lightly loaded and heavily loaded bearings, effects of end leakage on performance, Numerical problems. **14 Hours**

5. **Hydrostatic Bearings:** Hydrostatic thrust bearings, hydrostatic circular pad, annular pad, rectangular pad bearings, types of flow restrictors, expression for discharge, load carrying capacity and condition for minimum power loss, numerical problems, and hydrostatic journal bearings.
   EHL Contacts: Introduction to Elasto- hydrodynamic lubricated bearings. Introduction to 'EHL' constant, Grubin type solution. **14 Hours**

NOTE: Students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books

1. Mujamdar.B.C "Introduction to Tribology of Bearing", Wheeler Publishing, New Delhi 2001
2. Radzimovsky, "Lubrication of Bearings - Theoretical principles and design" Oxford press Company, 2000

Reference Books

1. Dudley D. Fulier " Theory and practice of Lubrication for Engineers", New YorkCompany.1998
2. Moore "Principles and applications of Tribology" Pergamon press, 1975
3. Oscar Pinkus, Beno Sternlicht, “Theory of hydro dynamic lubrication”, McGraw-Hill, 1961
4. G W Stachowiak, A W Batchelor, “Engineering Tribology”, Elsevier publication 1993.
5. Hydrostatic and hybrid bearings, Butterworth 1983.
6. F. M. Stansfield, Hydrostatic bearings for machine tools and similar applications, Machinery Publishing, 1970

Course Outcome:

Upon completion of this course, the student will be able to

CO1	Students develop skills to design and selection of bearings on Various tribological factors to be considered in moving and rotating parts.
CO2	The students are exposed to orient towards the various types of bearings and their applications.
CO3	Students are exposed to synthesis and analysis of the bearings including fault diagnosis.

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (First100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Unit	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.

3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	3	2	2	3	2	3	1	3	3
CO2	2	3	3	2	3	3	3	1	2	3	3	2
CO3	3	3	2	3	3	3	1	3	3	2	3	2
CO4	3	3	2	3	3	2	3	2	1	2	3	3

ADMISSION YEAR:2018-19 **ACADEMIC YEAR: 2018-19**

COURSE TITLE: DESIGN OPTIMIZATION		
Sub Code:18MMD232	**No of Credits: L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week: 04**
Exam Duration: 3 hours	**CIE Marks: 50**	**Exam Marks: 50**
Pre-requisites	**Research methodology, Composite material, Basic mathematics**	

COURSE OBJECTIVES:

It aids the students to acquire the basics of optimum design, Classical Optimization Techniques, Non - linear Programming, Unconstrained Optimization Techniques, Integer Programming and Dynamic Programming.To study the basics of Design optimization. To acquaint Optimum Design Problem Formulation. To study the Sensitivity Analysis, Linear and Non-Linear Approximations and Optimization Disciplines.To gain knowledge of different Manufacturability in Optimization Problems and Design Interpretation.

#	CONTENTS	Hrs
UNIT-1	**Engineering Design Practice:** Evolution of Design Technology, Introduction to Design and the Design Process, Design versus Analysis, Role of Computers in Design Cycle, Impact of CAE on Design, Numerical Modeling with FEA and Correlation with Physical Tests.	08
UNIT-2	**Optimum Design Problem Formulation**: Types of Optimization Problems, The Mathematics of Optimization, Design Variables and Design Constraints, Feasible and Infeasible Designs, Equality and Inequality Constraints, Discrete and Continuous Optimization, Linear and Non-Linear Optimization. **Optimization Theory** – Fundamental Concepts, Global and Local Minimum, Gradient Vector and Hessian Matrix, Concept of Necessary and Sufficient Conditions, Constrained and Unconstrained Problems, Lagrange Multipliers and Kuhn Tucker Conditions	08
UNIT-3	**Sensitivity Analysis, Linear and Non-Linear Approximations**. Gradient Based Optimization Methods – Dual and Direct. **Optimization Disciplines:** Conceptual Design Optimization and Design Fine Tuning, Combined Optimization, Optimization of Multiple Static and Dynamic Loads, Transient Simulations, Equivalent Static Load Methods	08
UNIT-4	**Manufacturability in Optimization Problems:** Design For Manufacturing, Manufacturing Methods and Rules, Applying Manufacturing Constraints to Optimization Problems. **Design Interpretation:** Unbound Problems, Over Constrained Problems, Problems with No of Multiple Solutions, Active and Inactive Constraints, Constraint Violations and Constraint Screening, Design Move Limits, Local and Global Optimum	14

UNIT-5	**Dynamic Programming:** Introduction, Multistage decision processes, Principle of optimality, Computational Procedure in dynamic programming, Initial value problem, Examples. **Applications of Optimization in Engineering Design:** Automotive, Aerospace and General Industry Applications, Optimization of Metallic and Composite Structures, Minimization and Maximization Problems, MDO and MOO	14

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. S.S. Rao, Engineering Optimization: Theory and Practice, John Wiley, 2009
2. JasbirArora, Introduction to Optimum Design, McGraw Hill, 2011.

Reference Books:

1. Optimization and Probability in System Engg - Ram, Van Nostrand.
2. Optimization methods - K. V. Mital and C. Mohan, New age International Publishers, 1999.
3. Optimization methods for Engg. Design - R.L Fox, Addison – Wesley, 1971.

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (First100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Unit	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

Course Outcome:

At the completion of this course, students will be able to:

CO1	It provides the student with knowledge required to optimize an existing design with single or multiple objective functions.
CO2	Skills acquired through commercial optimization programs
CO3	Acquire the knowledge of engineering system design

MAPPING OF COs WITH Pos

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	3	2	2	3	2	3	1	3	3
CO2	2	3	3	2	3	3	3	1	2	3	3	2
CO3	3	3	2	3	3	3	1	3	3	2	3	2
CO4	3	3	2	3	3	2	3	2	1	2	3	3

ADMISSION YEAR : 2018-19 ACADEMIC YEAR: 2018-19

COURSE TITLE: COMPOSITE MATERIALS TECHNOLOGY		
Sub Code:18MMD241	**No of Credits: L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week: 04**
Exam Duration: 3 hours	**CIE Marks: 50**	**Exam Marks: 50**
Pre-requisites	MECHATRONICS, COMPOSITE MATERIALS, SMART MATERIALS	

COURSE OBJECTIVES:

To study the basics of Composite materials. To acquaint mechanics of lamina. To study the micro and macro analysis of the lamina. To gain knowledge of different techniques involved in production of composites.

#	CONTENTS	Hrs
UNIT-1	**Introduction to Composite Materials:** Definition, Classification, Types of matrices material and reinforcements, Characteristics &selection, Fiber composites, laminated composites, Particulate composites, Prepegs, and sandwich construction. **Metal Matrix Composites:** Reinforcement materials, Types, Characteristics and selection, Base metals, Selection, Applications	08
UNIT-2	**Macro Mechanics of a Lamina:** Hooke's law for different types of materials, Number of elastic constants, Derivation of nine independent constants for orthotropic material, Two - dimensional relationship of compliance and stiffness matrix. Hooke's law for two-dimensional angle lamina, engineering constants - Numerical problems. Invariant properties. Stress-Strain relations for lamina of arbitrary orientation, Numerical problems.	08
UNIT-3	**Micro Mechanical Analysis of a Lamina:** Introduction, Evaluation of the four elastic moduli, Rule of mixture, Numerical problems. Experimental Characterization of Lamina- Elastic Moduli and Strengths **Failure Criteria:** Failure criteria for an elementary composite layer or Ply, Maximum Stress and Strain Criteria, Approximate strength criteria, Inter-laminar Strength, Tsa-Hill theory, Tsai, Wu tensor theory, Numerical problem, practical recommendations	08
UNIT-4	**Macro Mechanical Analysis of Laminate**: Introduction, code, Kirchoff hypothesis, Classical Lamination Theory, A, B, and D matrices (Detailed derivation), Special cases of laminates, Numerical problems. Shear Deformation Theory, A, B, D and E matrices (Detailed derivation) **Analysis of Composite Structures:** Optimization of Laminates, composite laminates of uniform strength, application of optimal composite structures, composite pressure vessels, spinning composite disks, composite lattice structures	14
UNIT-5	**Manufacturing and Testing:** Layup and curing - open and closed Mould processing, Hand lay-up techniques, Bag moulding and filament winding. Pultrusion, Pulforming, Thermoforming, Injection moulding, Cutting, Machining, joining and repair. NDT tests – Purpose, Types of defects, NDT method - Ultrasonic inspection, Radiography, Acoustic emission and Acoustic ultrasonic method.	14

	Applications: Aircrafts, missiles, Space hardware, automobile, Electrical and Electronics, Marine, Recreational and sports equipment-future potential of composites. .	

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. Autar K. Kaw, Mechanics of Composite materials, CRC Press, 2nd Ed, 2005.
2. Madhijit Mukhopadhay, Mechanics of Composite Materials & Structures, Universities Press, 2004.

Reference Books:

1. J. N. Reddy, Mechanics of Laminated Composite Plates & Shells, CRD Press, 2nd Ed, 2004.
2. Mein Schwartz, Composite Materials handbook, McGraw Hill, 1984.
3. Rober M. Jones, Mechanics of Composite Materials, Taylor & Francis, 1998.
4. Michael W, Hyer, Stress analysis of fiber Reinforced Composite Materials, Mc-Graw Hill International, 2009.
5. Composite Material Science and Engineering, Krishan K. Chawla, Springer, 3e, 2012.
6. Fiber Reinforced Composites, P.C. Mallik, Marcel Decker, 1993.

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (First100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Unit	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

Course Outcome:

At the completion of this course, students will be able to:

CO1	Identify the role of matrices and reinforcements used in practical composite structures.
CO2	Analyze problems on micro and macro mechanical behavior of lamina.
CO3	Assess the strength of laminated composite and predict its failure for given static loading conditions.
CO4	Develop understanding of different methods of manufacturing and testing of composites.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	3	2	2	3	2	3	1	3	3
CO2	2	3	3	2	3	3	3	1	2	3	3	2
CO3	3	3	2	3	3	3	1	3	3	2	3	2
CO4	3	3	2	3	3	2	3	2	1	2	3	3

ADMISSION YEAR : 2018-19 ACADEMIC YEAR: 2018-19

COURSE TITLE: FINITE ELEMENT METHODS FOR HEAT TRANSFER AND FLUID FLOW ANALYSIS		
Sub Code: 18MMD242	**No of Credits: L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week: 04**
Exam Duration: 3 hours	**CIE Marks: 50**	**Exam Marks: 50**
Pre-requisites	FINITE ELEMENT METHODS, BASIC THERMODYNAMICS, HEAT AND MASS TRANSFERR	

COURSE OBJECTIVES:

To study the basic sources of Heat transfer and fluid mechanics. To acquaint with the effects of steady state conduction heat transfer. To study the advance topic in conduction. To gain knowledge of Flows of Viscous Incompressible Fluids.

#	CONTENTS	Hrs
UNIT-1	**Introduction to Heat Transfer and Fluid Mechanics:** Mathematical Preliminaries, Governing equations of a continuum, Governing equation in terms of primitive variables, porous equations, low speed compressible flow equations, auxiliary transport equations, chemically reacting systems, boundary conditions, change of phase, enclosure radiation. **Finite Element Methods:** Introduction, model differential equation, finite element approximations, interpolation functions, library of finite elements, modeling considerations, assembly of elements, numerical integration, discussion of results with some practical examples, time dependent problems.	08
UNIT-2	**Steady State Conduction Heat Transfer:** Introduction, one dimensional linear, quadratic element. Homogeneous, composite wall with uniform and varying cross-sectional area. Radial heat flow in a cylinder. Conduction –convection systems. Numerical examples. **Conduction Heat Transfer:** Interpolation functions for tetrahedral, hexahedral, pyramid and prism elements. Numerical integration, computation of surface flux, semi-discrete finite element model,	08
UNIT-3	**Advanced topic in Conduction:** specialty elements, computation of boundary conditions, bulk nodes, reactive materials, material motions Example problems on conduction, radiation, temperature dependent conductivity, anisotropic conduction, brazing and welding, investment casting.	08
UNIT-4	**Flows of Viscous Incompressible Fluids:** Governing equation mixed finite element model, penalty finite element models. Finite element models of porous flow, solution of nonlinear equations for transient problems. Radiation algorithms. Variable properties. **Computational consideration:** Interpolation functions for triangular, quadrilateral, tetrahedral and hexahedral elements. Evaluation of element matrices in penalty model, pressure calculation and traction boundary conditions. Numerical examples	14
UNIT-5	**Coupled Fluid Flow and Heat Transfer:** Introduction to non-isothermal incompressible flows, governing equations and boundary condition. Mixed, penalty finite element model. Finite element model for porous flow. Non-isothermal low speed compressible flows: governing equation, boundary conditions, mixed finite element model and solution methods. Convection with change of phase, convection with enclosure radiation, turbulent heat transfer, chemically reacting systems. Numerical examples.	14

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. J N Reddy, David K. Gartling, "The finite element method in heat transfer and flu id dynamics" , CRC, 2004.
2. Roland Wynne Lewis, Perumal Nithiarasu, K. N. Seetharamu," Fundamentals of the finite element method for heat and fluid flow"
   John Wiley, 2004

Reference Books:

1. Ching Jen Chen, R. A. Bernatz, "Finite analytic method in flows and heat transfer", Taylor & Francis.
2. Gianni Comini, Stefano Del Giudice, Carlo Nonino, "Finite Element Analysis in Heat Transfer: Basic Formulation and Linear problems" Taylorand Francis, 1994.

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (First100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Unit	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

Course Outcome:

Upon completion of this course, the student will be able to

CO1	This course enables the student to use numerical methods for solving problems of fluid flow and heat transfer.
CO2	Analyze of the continuum mechanics problems like fluid flow, heat transfer.
CO3	Analyze of incompressible and compressible fluids.
CO4	Analyze modes of conduction in various mechanical systems

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	3	2	2	3	2	3	1	3	3
CO2	2	3	3	2	3	3	3	1	2	3	3	2
CO3	3	3	2	3	3	3	1	3	3	2	3	2
CO4	3	3	2	3	3	2	3	2	1	2	3	3

ADMISSION YEAR:2018-19 **ACADEMIC YEAR: 2018-19**

COURSE TITLE: THEORY OF PLASTICITY		
Sub Code: MMD251	**No of Credits: L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week: 04**
Exam Duration: 3 hours	**CIE Marks: 50**	**Exam Marks: 50**
Pre-requisites	**DESIGN OF MACHINE ELEMENTS, ADVANCED MECHANICS OF SOLIDS.**	

COURSE OBJECTIVES:

To study the basic concept of stresses, stress distribution, elastic constants when the material is subjected to loading within the elastic limits. Study the stress distribution in plane, polar and cylindrical coordinate systems. Analyze the material or component subjected to torsion of circular and non-circular shafts (elliptical, triangular bars) Study the thermo-elastic properties of the material at elevated temperatures.

#	CONTENTS	Hrs
UNIT-1	**DEFINITION AND SCOPE OF THE SUBJECT:** Brief review of elasticity, Octahedral normal and shear stresses, Spherical and deviatoric stress, Invariance in terms of the deviatoric stresses, Engineering and natural strains, Mathematical relationships between true stress and true strains, Cubical dilation, finite strains co- efficient Octahedral strain, Strain rate and the strain rate tensor.	08
UNIT-2	**BENDING OF BEAMS:** Torsion of rods and tubes, Nonlinear bending and torsion equations, Simple forms of indentation problems using upper bounds, Application of Metal forming: Extrusion, Drawing, Rolling and Forging.	08
UNIT-3	**SLIP LINE THEORY**: Introduction, Basic equations for incompressible two-dimensional flow, continuity equations, Stresses in conditions of plain strain convention for slip-lines, Geometry of slip lines, Properties of slip lines.	08
UNIT-4	**MATERIAL MODELS:** Stress-strain relations, Yield criteria for ductile metal, Von Mises, Tresca, Yield surface for an Isotropic Plastic material, Stress space, Experimental verification of Yield criteria, Yield criteria for an anisotropic material, flow rule normality of Yield locus, Symmetry and convexity, Deformation of isotropic and kinematic hardening, bilinear stress-strain relationship.	14
UNIT-5	**PLASTIC STRESS-STRAIN RELATIONS:** Prandtl-Reuss Saint Venant, Levy-Mises, Experimental verification of the Prandtl-Reuss equation, Upper and lower bound theorems. Application to problems: Uniaxial tension and compression.	**1**4

TEXT BOOKS

1. **R. A. C. Slater**, "Engineering Plasticity - Theory and Application to Metal Forming Process", McMillan Press Ltd., 1977.

2. **SADHU SINGH, "Theory of Plasticity and Metal forming Process", Khanna Publishers, Delhi, 1999.**

REFERENCE BOOKS

1. **HOFFMAN AND SACHS**, "Introduction to the Theory of Plasticity for Engineers", LLC, 2012.
2. **J CHAKRABARTY**, "Theory of plasticity", Butterworth, 2006. 3. Johnson and Mellor, "Plasticity for Mechanical Engineers", Van Nostrand, 1966.
3. **PLASTICITY FOR MECHANICAL ENGINEERS** - Johnson and Mellor, Van Nostrand, 1966.

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (First100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Unit	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO1	Apply basic concepts in continuum mechanics of solids viz. Stress and strain tensors, equilibrium, compatibility and constitutive equations and methods of solution to elasticity problems
CO 2	Evaluate stresses and displacements in simple solids such as pressurized cylinders, shrink fitted cylinders, rotating disc and shaft, plate with hole and non-circular shafts and thin tubes under torsion.
CO 3	Use MATLAB or equivalent software to evaluate and plot particular solutions.
CO 4	Apply the principles of plastic deformation to estimate yielding in simple engineering structures.
CO 5	Apply principles of continuum mechanics to design a structure or component to achieve desired performance under realistic constraints.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	2	2	3	3	2	3	3	1	2
CO2	2	3	3	2	2	1	3	2	3	3	3	2
CO3	3	3	3	2	3	2	3	1	3	2	3	2
CO4	3	3	2	2	3	2	3	1	2	2	3	3

ROTOR DYNAMICS

Course Code	**:**	**18MMD252**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:
To make student to understand the concept of turbo machinery. To enable them to design specifically modeling of bearings, shafts and rotor stages. To guide them to predict instability like whirling including gyroscopic and Coriolis effect. To find the methods of reducing blade vibrations

1. **Fluid Film Lubrication:** Basic theory of fluid film lubrication, Derivation of generalized Reynolds equations, Boundary conditions, Fluid film stiffness and Damping coefficients, Stability and dynamic response for hydrodynamic journal bearing, Two lobe journal bearings.
08 Hours

2. **Critical Speed:** Dunkerley's method, Rayleigh's method, Stodola's method. Rotor Bearing System: Instability of rotors due to the effect of hydrodynamic oil layer in the bearings, support flexibility, Simple model with one concentrated mass at the center.
Introduction to Jeffcott rotor. Concepts, mathematical equations, applications. **08 Hours**

3. **Turbo rotor System Stability by Transfer Matrix Formulation:** General Turborotor system, development of element transfer matrices, the matrix differential equation, effect of shear and rotary inertia, the elastic rotors supported in bearings, numerical solutions. **08 Hours**

4. **Turbo rotor System Stability by Finite Element Formulation:** General Turborotor system, generalized forces and co-ordinates system assembly element matrices, Consistent mass matrix formulation, Lumped mass model, linearized model for journal bearings, System dynamic equations Fix stability analysis non dimensional stability analysis, unbalance response and Transient analysis. **14 Hours**

5. **Blade Vibration:** Centrifugal effect, Transfer matrix and Finite element, approaches. **14 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry.

Reference Books:

1. Cameron, “Principles of Lubrication”, Longman Publishing Group, 1986
2. Bolotin, “Nonconservative problems of the Theory of elastic stability”, Macmillan, 1963
3. Peztel, Lockie, “Matrix Methods in Elasto Mechanic s”, McGraw-Hill, 1963.
4. Timoshenko, “Vibration Problems in Engineering”, Ox ford City Press, 2011
5. Zienkiewicz, “The finite element method in engineering science”, McGraw-Hill, 1971

Course Outcomes:

Upon completion of this course, the student will be able to

CO1	Model a rotating machine element theoretically for rotor dynamic analysis.
CO2	Analyze Free and Forced lateral response of simple rotor models and of more complex systems including shafts, bearings, seals and stators.
CO3	Formulate Finite element and carry out analysis for Turborotor System Stability.
CO4	Apply Finite element approach to blade vibration.

SYLLABUS COVERAGE FOR CIE-1, 2, 3
CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (First100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Unit	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	2	2	3	3	2	3	3	1	2
CO2	2	3	3	2	2	1	3	2	3	3	3	2
CO3	3	3	3	2	3	2	3	1	3	2	3	2
CO4	3	3	2	2	3	2	3	1	2	2	3	3

RESEARCH METHODOLOGY

Course Code	**:**	**18RM27**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 2:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**02**		**SEE Duration**	**:**	**3 hours**

Course Learning Objectives: Students are expected to

- Have a basic understanding of the underlying principles of quantitative and qualitative research
- Identify the overall process of designing a research study from its inception to its report.
- Choose the most appropriate research method to address a particular research question
- Gain a overview of a range of quantitative and qualitative approaches to data analysis

1. **Overview of Research:** Research and its types, identifying and defining research problem and introduction to different research designs. Essential constituents of Literature Review. Basic principles of experimental design, Primary data and Secondary Data, methods of primary data collection, classification of secondary data, designing questionnaires and schedules. **8 Hours**

2. **Sampling Methods:** Probability sampling: simple random sampling, systematic sampling, stratified sampling, cluster sampling and multistage sampling. Non-probability sampling: convenience sampling, judgment sampling, quota sampling. Sampling distributions. **6 Hours**

3. **Processing and analysis of Data:** Statistical measures and their significance: Central tendencies, variation, skewness, Kurtosis, time series analysis, correlation and regression, Testing of Hypotheses: Parametric (t and Chi Square). **6 Hours**

4. **Essential of Report writing and Ethical issues**: Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Ethical issues related to Research, Plagiarism and self- Plagiarism, Publishing. **6 Hours**

Reference Books:

1. Krishnaswami, K.N., Sivakumar, A. I. and Mathirajan, M., Management Research Methodology, Pearson Education: New Delhi.
2. Kothari C.R., Research Methodology Methods and techniques by, New Age International Publishers, 2nd edition
3. Levin, R.I. and Rubin, D.S., Statistics for Management, 7th Edition, Pearson Education: New Delhi.

Course Outcome:

At the end of the course students will:

CO1	Describe a range of quantitative and qualitative research designs and identify the advantages and disadvantages associated with these designs
CO2	Choose appropriate quantitative or qualitative method to collect data
CO3	Analyse and test the given data using appropriate methods
CO4	Design an appropriate mixed-method research study to answer a research question

SEMESETER III

ADMISSION YEAR:2018-19 **ACADEMIC YEAR: 2018-19**

COURSE TITLE: FRACTURE MECHANICS		
Sub Code: 18MMD31	**No of Credits: L-T-P-SS** **4:0:0:0=4**	**No. of lecture hours/week :04**
Exam Duration :3 hours	**CIE Marks:50**	**Exam Marks :50**
Pre-requisites	**Metrology & Measurements, Design of Machine Elements'**	

COURSE OBJECTIVES:

Fracture mechanics provides a methodology for prediction, prevention and control of fracture in materials, components and structures. It provides a background for damage tolerant design. It quantifies toughness as materials resistance to crack propagation.

#	CONTENTS	Hrss
UNIT-1	**FRACTURE MECHANICS PRINCIPLES:** Introduction and historical review, Sources of micro and macro cracks. Stress concentration due to elliptical hole, Strength ideal materials, Griffith's energy balance approach. Fracture mechanics approach to design. NDT and Various NDT methods used in fracture mechanics. The Airy stress functions. Complex stress function. Effect of finite size. Special cases, Elliptical cracks.	08
UNIT-2	**PLASTICITY EFFECTS:** Irwin plastic zone correction. Dugdale approach. The shape of the plastic zone for plane stress and plane strain cases, Plastic constraint factor. The Thickness effect, numerical problems. **Determination of Stress intensity factors and plane strain fracture toughness**: Introduction, analysis and numerical methods, experimental methods, estimation of stress intensity factors. Plane strain fracture toughness test, The Standard test.	08
UNIT-3	**THE ENERGY RELEASE RATE:** Criteria for crack growth. The crack resistance (R curve). Compliance, J integral. Tearing modulus. Stability.	08

UNIT-4	**ELASTIC PLASTIC FRACTURE MECHANICS:** Fracture beyond general yield. The Crack-tip opening displacement. The Use of CTOD criteria. Experimental determination of CTOD. Parameters affecting the critical CTOD. Use of J integral. Limitation of J integral. **DYNAMICS AND CRACK ARREST:** Crack speed and kinetic energy. Dynamic stress intensity and elastic energy release rate. Crack branching. Principles of crack arrest. Crack arrest in practice. Dynamic fracture toughness**.**	14
UNIT-5	**FATIGUE CRACK PROPAGATION AND APPLICATIONS OF FRACTURE MECHANICS:** Crack growth and the stress intensity factor. Factors affecting crack propagation. variable amplitude service loading, means to provide fail-safety, required information for fracture mechanics approach, Mixed mode (combined) loading and design criteria.	14

Text Books:

1. **David Broek,** "Elementary Engineering Fracture Mechanics", Springer Netherlands,2011
2. **Anderson**, "Fracture Mechanics-Fundamental and Application", T.L CRC press1998.

Reference Books:

1. **Karen Hellan**, "Introduction to fracture mechanics", McGraw Hill, 2nd Edition
2. **S.A. Meguid**, "Engineering fracture mechanics" Elsevier Applied Science, 1989
3. **Jayatilaka,** "Fracture of Engineering Brittle Materials", Applied Science Publishers, 1979
4. **Rolfe and Barsom**, "Fracture and Fatigue Control in Structures", Prentice Hall, 1977
5. **Knott**, "Fundamentals of fracture mechanisms", Butterworths, 1973

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)

CIE-2: UNIT-2 (50%) + UNIT -3 (Firs100%)

CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	

(Irrespective of portions covered due to whatever might be the reason)

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

COURSE OUTCOMES:

Learners will able to

CO1	Develop fundamental understanding of the effects of crack like defects on the performance of aerospace, civil, and mechanical engineering structures.
CO2	Select appropriate materials for engineering structures to ensure damage tolerance.
CO3	Employ modern numerical methods to determine critical crack sizes and fatigue crack propagation rates in engineering structures.
CO4	Gain appreciation of the status of academic research in field of fracture mechanics.

MAPPING OF COs WITH Pos

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	-	-	-	-	3	2	-	1	-	-
CO2	2	3	-	2	-	-	-	-	-	3	-	-
CO3	3	3	-	-	-	3	-	-	-	-	--	-
CO4	3	3	2	-	-	1	-	-	-	-	-	-

ADMISSION YEAR:2018-19 **ACADEMIC YEAR: 2019-2020**

COURSE TITLE: SMART MATERIALS AND STRUCTURES		
Sub Code: 18MMD321	**No of Credits: L-T-P-S** **4:0:0:0 =4**	**No. of lecture hours/week :04**
Exam Duration: 3 hours	**CIE Marks: 50**	**Exam Marks:50**
Pre-requisites	Mechatronics, Composite materials technology**.**	

COURSE OBJECTIVES:

To study the basic sources of smart materials and structures. To acquaint with the effects of Shape memory Alloy, ER and MR fluids. To study the usefulness of vibration absorbers and control of structures. To gain knowledge of MEMS and devices.

#	CONTENTS	Hrss
UNIT-1	**Smart Structures**: Types of Smart Structures, Potential Feasibility of Smart Structures, Key Elements of Smart Structures, Applications of Smart Structures. Piezoelectric materials, Properties, piezoelectric Constitutive Relations, Depoling and Coersive Field, field strain relation. Hysteresis, Creep and Strain Rate effects, Inchworm Linear Motor.	08
UNIT-2	**Beam Modeling:** Beam Modeling with induced strain Rate effects, Inchworm Linear Motor Beam Modeling with induced strain Actuation-single Actuators, dual Actuators, Pure Extension, Pure Bending harmonic excitation, Bernoulli-Euler beam Model, problems, Piezoelectric Applications.	08
UNIT-3	**Shape memory Alloy:** Experimental Phenomenology, Shape Memory Effect, Phase Transformation, Tanaka's Constitutive Model, testing of SMA Wires, Vibration Control through SMA, Multiplexing. Applications Of SMA and Problems. **ER and MR Fluids:** Mechanisms and properties, Fluid Composition and behavior, The Bingham Plastic and Related Models, Pre-Yield Response. Post-Yield flow applications in Clutches, Dampers and Others	08
UNIT-4	**Vibration Absorbers:** series and Parallel Damped Vibrations (Overview), Active Vibration Absorbers, Fiber Optics, Physical Phenomena, Characteristics, Sensors, Fiber Optics in Crack Detection, applications. **Control of Structures:** Modeling, Control Strategies and Limitations, Active Structures in Practice.	14
UNIT-5	**MEMS** – Mechanical Properties of MEMS Materials, Scaling of Mechanical Systems, Fundamentals of Theory, The Intrinsic Characteristics of MEMS, Miniaturization, Microelectronics Integration.	14

	Devices: Sensors and Actuators, Conductivity of Semiconductors, Crystal Planes and Orientation, (Stress and Strain Relations, Flexural Beam Bending Analysis Under Simple Loading Conditions), Polymers in MEMS, Optical MEMS Applications.	

Text Books:

1. Smart Materials and Structures -**M. V. Gandhi and B.S Thompson**, Chapman and Hall, London; New York, 1992 (ISBN: 0412370107).
2. Smart Structures and Materials **- Culshaw, Artech House, Boston**, 1996 (ISBN :0890066817).
3. Smart Structures: Analysis & Design **- A. Srinivasan**, Cambridge University Press, Cambridge; New York, 2001 (ISBN: 0521650267).

Reference Books:

1. Electro ceramics: Materials, Properties and Applications - **A. J. Moulson and J. M. Herbert**. John Wiley & Sons, ISBN: 0471497429
2. **Piezoelectric Sensories**: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors. Materials and Amplifiers, Springer, Berlin; New York, 2002 (ISBN: 3540422595).
3. Piezoelectric Actuators and Wtrasonic Motors -**K. Uchino, Kluwer** Academic Publishers, Boston, 1997 (ISBN: 0792398114).
4. Handbook of Giant Magneto strictive Materials - **G. Engdahl**, Academic Press, San Diego, Calif.; London, 2000 (ISBN: 012238640X).
5. Shape Memory Materials **- K. Otsuka and C.M. Wayman**, Cambridge University Press, Cambridge; New York, 199~ (ISBN: 052144487X).

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (100%)

CIE-2: UNIT-3 (100%) + UNIT -4 (50%)

CIE-3: UNIT- 4 (50%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	

(Irrespective of portions covered due to whatever might be the reason)

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

Course Outcome:

At the completion of this course, students will be able to:

CO1	Understand the behavior and applicability of various smart materials.
CO2	Design Simple models for smart structures and materials
CO3	Perform simulation of smart structures and material application.
CO4	Conduct experiments to verify the predictions.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	--	-	2	-	-	-	-	-	-	-
CO2	2	3	-	2	-	-	-	1	-	-	3	-
CO3	3	-	2	-	3	-	1	-	-	2	-	2
CO4	3	-	2	-	-	-	-	-	-	-	-	-

ADMISSION YEAR: 2018-19 **ACADEMIC YEAR: 2019-20**

COURSE TITLE: STATISTICAL MODELING AND EXPERIMENTAL DESIGN		
Sub Code: 18MMD322	**No of Credits: L-T-P-SS** **4:0:0:0=4**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**
Pre-requisites	Mom, Experimental Mechanics, Finite Element Method.	

COURSE OBJECTIVES:

The objective of this course is to impart students with a holistic view of the fundamentals of experimental designs, analysis tools and techniques, interpretation and applications.

	CONTENTS	**Hrss**
UNIT-1	**Statistical Modeling and Data Analysis:** Introduction, Review of basic statistical concepts: Concepts of random variable, Sample and population, Measure of Central tendency; Mean, median and mode. Illustration through Numerical examples, Normal, Log Normal & Weibull distributions. Illustration through Numerical examples.	10
UNIT-2	**Introduction to Designed Experiments:** Strategy of experimentation, some typical applications of experimental design, Basic principles, Guidelines for designing experiments, A brief history of statistical design, Summary: Using statistical techniques in experimentation.	10
UNIT-3	**Factorial Experiments** Basic definitions, The advantages of factorials, The two-factorial design. Introduction, Factorial Experiments Terminology: factors, levels, interactions, Two-level experimental designs for two factors and three factors. Illustration through Numerical examples.	10
UNIT-4	**Regression Analysis:** linear and multiple Regression analysis, Mathematical models from experimental data. Illustration through Numerical examples.	10
UNIT-5	**Signal to Noise Ratio:** Evaluation of sensitivity to noise. Signal to Noise ratios for static problems: Smaller-the-batter type, Nominal the-better-type, Larger-the better type. Signal to Noise for Dynamic problems. Illustration through Numerical examples.	**10**

TEXT BOOKS:

1. **Design and Analysis of Experiments,** Douglas C. Montgomery, 5th Edition Wiley India Pvt. Ltd. 2007.
2. **Quality engineering using robust design**, Madhav s. Phadke, Prentice Hall PTR, Englewood Cliffs, NewJersy 07632, 1989.

REFERENCES BOOKS:

1. Thomas B. Barker, **"Quality if experimental design",** Marcel Dekker Inc ASQC Quality Press.1985.
2. C.F. Jeff Wu Michael Hamada, **"Experiments Planning Analysis and Parameter Design Optimization",** Wiley Editions. 2002.
3. L. W. Condra**, "Reliability Improvement with design of Experiments",** 2nd ed, CRC Press, 2001
4. Phillip j. Ross, **"Taguchi Techniques for Quality Engineering",** 2nd ed. McGraw Hill International Editions, 1996.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)

CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

(Irrespective of portions covered due to whatever might be the reason)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO1	Basic statistics including ANOVA and regression.
CO2	Experimental designs such as RCBD, BIBD, Latin Square, factorial and fractional factorial designs.
CO3	Application of statistical models in analyzing experimental data.
CO4	RSM to optimize response of interest from an experiment.
CO5	Robust design of process and product.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	1	1	-	2	-	-	-	-	-	-	-	-
CO2	2	-	3	2	-	-	-	--	-	-	-	-
CO3	3	3	-	2	3	2	3	-	-	-	-	-
CO4	3	-	2	-	-	-	-	-	2	-	-	-

ADMISSION YEAR: 2018-19 **ACADEMIC YEAR: 2019-20**

COURSE TITLE: OPTIMIZATION TECHNIQUES		
Sub Code: 18MMD323	**No of Credits: L-T-P-SS** **4:0:0:0=4**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**
Pre-requisites	Mom, Experimental Mechanics, Finite Element Method.	

COURSE OBJECTIVES:

To understand the theory of optimization methods and algorithms developed for solving various types of optimization problems. To develop and promote research interest in applying optimization techniques in problems of Engineering and Technology. To apply the mathematical results and numerical techniques of optimization theory to concrete Engineering problems.

	CONTENTS	**Hrss**
UNIT-1	**Introduction:** Terminology, Design Variables, Constraints, Objective Function, Variable Bounds, Problem Formulation, Engineering Optimization Problems. Calculus method. Linear Programming. Simplex method, Concept of Duality.	08
UNIT-2	**Single Variable Optimization Problems:** Optimality Criterion, Bracketing Methods, Region Elimination Methods, Interval Halving Method, Fibonacci Search Method, Golden Section Method, Successive Quadratic Estimation Method. Gradient Based Methods: Newton-Raphson Method, Bisection Method, Secant Method. Application to Root finding.	08
UNIT-3	**Multivariable Optimization Algorithms:** Optimality Criteria, Unidirectional Search, Direct Search Methods: Hooke-Jeeves pattern search method, Powell's Conjugate Direction Method. Gradient Based Methods: Cauchy's Steepest Descent Method, Newton's method, Marquardt's Method.	08
UNIT-4	**Constrained Optimization Algorithms:** Kuhn Tucker conditions, Transformation Methods: Penalty Function Method, Method of Multipliers, Sensitivity analysis.	14

UNIT-5	**Topics in Optimization Techniques:** Quadratics Programming, sequential quadratic programming; Integer Programming, Penalty Function Method, Branch and Bound Method, Geometric Programming, Applications Design of experiments and Taguchi method – Application and problem solving; Dynamic programming, principle of optimality, recursive equation approach and applications; Genetic algorithm.	14

TEXT BOOKS:

1. S. S. Rao, **"Engineering Optimization: Theory and Practice",** John Wiley & Sons, 1996.

2. Kalyanmoy Deb, **"Optimization for Engineering Design: Algorithms and Examples",** 2nd ed, Prentice Hall of India, 2004.

REFERENCES BOOKS:

1. E. J. Haug and J. S. Arora, **"Applied Optimal Design",** Wiley, New York.
2. G.V. Reklaites, A. Ravindran and K.M. Rogsdeth, **"Optimization",** Wiley, New York.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)

CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

(Irrespective of portions covered due to whatever might be the reason)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO1	Formulate engineering optimization problem and solve LPP by simplex method.
CO2	Solve single and multivariable optimization problem by various relevant method.
CO3	Develop algorithm for constrained optimization.
CO4	Examine various optimization techniques and demonstrate their applicability.
CO5	Cast engineering minima/maxima problems into optimization framework.

MAPPING OF COs WITH Pos

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	1	1	-	-	-	-	-	-	3	-	-	-
CO2	2	3	-	-	2	1	-	-	-	-	-	2
CO3	3	-	3	-	3	-	-	-	-	-	-	-
CO4	3	1	2	-	-	-	-	-	-	-	-	3

ADMISSION YEAR: 2018-19 **ACADEMIC YEAR: 2019-20**

COURSE TITLE: THEORY OF PLATES AND SHELLS		
Sub Code: 18MMD324	**No of Credits: L-T-P-SS** **4:0:0:0=4**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**
Pre-requisites	Mom, Theory of Elasticity, Theory of Plasticity	

COURSE OBJECTIVES:

Understand the classical structural mechanics approximations of Membrane, Plate and Shell theories. Apply energy formulations to demonstrate the consistent derivation of approximate boundary conditions and edge effects. Identify the necessary tools to describe static, dynamic and non-linear motions. Evaluate the buckling, vibration and stress parameters in thin shells using numerical approximation techniques.

	CONTENTS	Hrss
UNIT-1	**General Introduction:** Review of equations of elasticity- kinematics, compatibility equations, stress measures- equations of motions- constitutive relations- transformation of stresses, strains and stiffness-energy principles and variational methods in elasticity- virtual work-external and internal virtual work variational operator- functionals- Euler Lagrange equations- energy principles- Hamilton's principle- principle of minimum total potential- applications.	08
UNIT-2	**Classical Theory of Plates:** Plates as structural elements- stress and moment resultants- assumptions made in the classical theory- displacement fields and strains- equations of equilibrium in Cartesian coordinates and in polar coordinates- boundary conditions – bending of rectangular plates with various boundary conditions and loading- symmetrical and asymmetrical bending of circular plates-limitations of classical theory- finite element analysis	08
UNIT-3	**Buckling Analysis of Rectangular Plates:** Buckling of simply supported plates under compressive forces- governing equations- the Navier solution- biaxial compression of a plate- uniaxial compression of a plate- buckling of plates simply supported on two opposite edges- Levy's solution- buckling of plates with various boundary conditions- general formulation- finite element analysis	08
UNIT-4	**Vibration of Plates:** Governing equations for natural flexural vibrations of rectangular plates- natural vibrations of plates simply supported on all edges- vibration of plates with two parallel sides simply supported Levy's solution- vibration of plates with different boundary conditions- Rayleigh-Ritz method Natural vibration of plates with general boundary conditions- transient analysis of rectangular plates- finite element analysis	14

UNIT-5	**Analysis of Thin Elastic Shells of Revolution:** Classification of shell surfaces- geometric properties of shells of revolution- general strain displacement relations for shells of revolution-stress resultants- equations of motion of thin shells, analytical solution for thin cylindrical shells-membrane theory- flexure under axisymmetric loads, shells with double curvature- geometric considerations- equations of equilibrium- bending of spherical shells- vibration of cylindrical shells.	**14**

TEXT BOOKS:

1. Reddy, J.N., "**Theory and Analysis of Elastic Plates & Shells**", C.R.C. Press, NY, USA, 2nd Edition, ISBN 9780849384158
2. Timoshenko, S. and Krieger S.W. **Theory of Plates and Shells**, McGraw Hill Book Company, New York 1990, ISBN 0-13-913426-3

REFERENCES BOOKS:

1. Szilard, R., **Theory and Analysis of Plates,** Prentice Hall Inc., 1999, ISBN 0-12-9353336-2
2. Wilhelm Flügge, **Stresses in shells,** Springer –Verlag, ISBN 978-3-662-01028-0

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)

CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

(Irrespective of portions covered due to whatever might be the reason)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO1	Apply the structural mechanics approximations of membrane, plates and shells.
CO2	Develop simple modifications to the membrane plate and shell theories
CO3	Describe the static, dynamic, and non-linear motion of membrane, plate and shell structures.
CO4	Analyze numerical problems in shells of revolution.

MAPPING OF COs WITH Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	3	1	-	-	-	-	-	-	-
CO2	-	-	-	2	-	1	-	-	-	-	-
CO3	3	1	1	-	-	-	-	-	-	-	-
CO4	1	2	-	3	3	1	-	-	-	-	-

ADMISSION YEAR: 2018-19 **ACADEMIC YEAR: 2019-20**

COURSE TITLE: COMPUTER APPLICATIONS IN DESIGN		
Sub Code: 18MMD331	**No of Credits: L-T-P-SS** **4:0:0:0=4**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**
Pre-requisites	Mom, Finite Element Method.	

COURSE OBJECTIVES:

Memorize the equations of transformations, curves, solid models and surfaces. Understand the concept of computer Graphics. Demonstrate the principles of wire frame, Geometric, and surface modeling. Distinguish the different concepts of algorithm.

	CONTENTS	Hrss
UNIT-1	**Computer Graphics:** Line drawing algorithms: DDA, Bresenham's algorithms, Mid-point circle algorithms, coordinate systems, windowing, View generation, Clipping, Transformations of geometry.	10
UNIT-2	**Software Configuration:** Software configuration of a graphics system, Functions of a graphics package, Mathematics of projections, Hidden line removal, Hidden surface removal, Shading, Rendering. **Basics of geometry modeling:** Requirements of geometric modeling, geometric models, geometric construction methods, modeling facilities desired.	10
UNIT-3	**Wireframe Modeling:** Classification of wire frame entities, curve representation methods, parametric representation of analytic curves, curvature continuity, Lagrange interpolation, Parametric representation of synthetic curves, curve manipulations.	10
UNIT-4	**Solid Modeling:** Application of solid models, modeling considerations of solids, geometry and topology, solid modeling scheme, Boundary Representation, Winged edge data structure for Boundary representation, Euler operations, Constructive solid geometry, Sweeping, Solid Manipulations.	10
UNIT-5	**Surface modeling:** Introduction, Planes, Vector Planes, surface entities, Surface representation methods, Quadratic Surface in normal forms, Quadratic Surface in general forms, Quadratic Surface in matrix form, parametric surfaces, Parametric representation of analytic surfaces, Parametric representation of synthetic surfaces, Surface Manipulations.	**10**

TEXT BOOKS:

1. Chennakesava R Alavala **"CAD/CAM Concepts and Applications",** 1st Ed PHI, New Delhi, 2009.
2. P.N. Rao**, "CAD/CAM Principles and Applications",** 3rd Ed., McGraw Hill, Education Pvt Ltd.

REFERENCES BOOKS:

1. Ibrahim Zeid, **"Mastering CAD/CAM",** 2nd Ed., TMH Publishing Company Limited., New Delhi.
2. M.P. Groover and 3 E W Zimmers**, CAD/CAM Computer aided Design and Manufacturing**, 9^{th} Ed, 1993.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)

CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

(Irrespective of portions covered due to whatever might be the reason)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO1	Discuss the concepts of Computer Graphics in CAD in product development
CO2	Apply the concepts of CAD in the manufacturing industry
CO3	Analyze the concepts of computer Aided Design
CO4	Evaluating the techniques involved in CAD.

MAPPING OF COs WITH POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	3	3	-	-	-	-	-	-	-	-
CO2	3	2	2	1	-	-	-	-	-	-	-
CO3	1	3	-	3	2	-	-	-	-	-	-
CO4	-	-	1	2	3	1	-	-	-	-	-

- High-3
- Medium-2
- Low-1

ADMISSION YEAR: 2018-19 **ACADEMIC YEAR: 2019-20**

COURSE TITLE: ADVANCED SYSTEM DESIGN		
Sub Code: 18MMD332	**No of Credits: L-T-P-SS** **4:0:0:0=4**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**
Pre-requisites	Mom, Project Management, Engineering Economics.	

COURSE OBJECTIVES:

To study the basic concepts of different types of design. Need analysis in engineering systems
Analyze the concept of design with respect to economics and optimization.

	CONTENTS	Hrss
UNIT-1	**INTRODUCTION**: What is designing, Man as a designer: Design by evolution, inadequacies of traditional design method: System approach of engineering problems: Need models: design history of large-scale existing system. Morphology of Design: The three phases of design projects, the structure of design process, decision making and iteration.	10
UNIT-2	**Identification, Need analysis &Design Concept:** Preliminary need statement, analysis of need, specifications, and standards of performance and constraints. Process of idealization, mental fixity, analysis, AIDA, brain storming etc.	10
UNIT-3	**Preliminary Design:** Mathematical modeling for functional design: concept of sensitivity, compatibility and stability analysis. Evaluation Of Alternatives and Design Decisions.	10
UNIT-4	**Design Tree:** Quality of design, Concept of utility, multi criteria decisions, decisions under uncertainty and risk (Numerical), Bath tub curve, exponential reliability function, system reliability concept. (Numerical)	10
UNIT-5	**Economics And Optimization in Engineering Design**: Economics in Engineering Design, Fixed and variable costs, break-even analysis. (Numerical) Optimization: Introduction to LPP. Man, Machine Interaction, Designing for use and maintenance, Man-Machine Cycle, Design of displays and controls. Factors influencing displays and controls.	**10**

REFERENCES BOOKS:

1. **Mechanical System Design** by: W. E. Eder lecturer In Mechanical Engineering And’s. Gosling
2. Harrison Kim, Dept. of Industrial and Enterprise Systems Engineering (ISE) - 2 - 1. Papa Lambros, P.Y. and Wilde, D., **Principles of Optimal Design** (2nd Ed.), Cambridge University Press, New York, 2000. 2.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)

CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

(Irrespective of portions covered due to whatever might be the reason)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO1	Analyze the types of design and concepts
CO2	Applying the concept of need based design.
CO3	Implement preliminary design concept in real life.
CO4	Analyzing the process of design in the form of sequence of actions.

MAPPING OF COs WITH POs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO 1
1	3	--	-	-	-	-	-	-	-	1	-	2
2	2	-	3	-	1	-	3	-	-	-	-	-
3	3	3	2	-	-	-	-	-	-	-	-	-
4	3	3	2	1	-	-	-	-	-	-	-	-

- High-3
- Medium-2
- Low-1

ADMISSION YEAR: 2018-19 **ACADEMIC YEAR: 2019-20**

COURSE TITLE: DESIGN OF HYDRAULICS AND PNEUMATICS		
Sub Code: 18MMD333	**No of Credits: L-T-P-SS** **4:0:0:0=4**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**
Pre-requisites	Mom, Design of Machine Elements, Finite Element Method.	

COURSE OBJECTIVES:

Identify the symbolic representation of hydraulic systems. Understand the working of industrial systems employing fluid power. Identify the working of hydraulic circuits. Select the appropriate components through design calculations and Demonstrate the electronic components in pneumatic systems.

	CONTENTS	Hrss
UNIT-1	**Hydraulic Actuators and Motors:** Pascal's law and problems on Pascal's Law, continuity equations, introduction to conversion of units. Structure of Hydraulic Control System Linear Hydraulic Actuators [cylinders], Mechanics of Hydraulic Cylinder loading, Hydraulic Rotary Actuators, Gear motors, vane motors, piston motors, Hydraulic motor theoretical torque, power and flow rate, and hydraulic motor performance.	08
UNIT-2	**Control Components in Hydraulic Systems:** Directional Control Valves – Symbolic representation, Constructional features, pressure control valves – direct and pilot operated types, flow control valves. **Hydraulic Circuit Design and Analysis:** Control of single and double – acting Hydraulic Cylinder, regenerative circuit, pump unloading circuit, Double pump Hydraulic system, Counter Balance Valve application, and Hydraulic cylinder sequencing circuits. Locked cylinder using pilot check valve, cylinder synchronizing circuits, speed control of hydraulic cylinder, speed control of hydraulic motors, accumulators and accumulator circuits.	08
UNIT-3	**Introduction to Pneumatic Control:** Choice of working medium, characteristics of compressed air. Structure of Pneumatic control system. Pneumatic Actuators: Linear cylinders – Types, conventional type of cylinder working, end position cushioning, seals, mounting arrangements applications. Rod–less cylinders, types, working advantages. Rotary cylinder types construction and application. Design parameters, selection.	08
UNIT-4	**Directional Control Valves:** Symbolic representation as per ISO 1219 and ISO 5599. Design and constructional aspects, poppet valves, slide valves spool valve, suspended seat type slide valve. Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, use of memory valve.	14

	Flow control valves and speed control of cylinders supply air throttling and exhaust air throttling use of quick exhaust valve. Signal processing elements: Use of Logic gates – OR and AND gates pneumatic applications. Practical examples involving the use of logic gates. Pressure dependent controls types construction–practical applications. Time dependent controls – Principle, construction, practical applications.	
UNIT-5	**Multi-cylinder Applications:** Coordinated and sequential motion control. Motion and control diagrams – Signal elimination methods. Cascading method – principle. Practical application examples (up to two cylinders) using cascading method (using reversing valves). Electro-Pneumatic control: Principles-signal input and output pilot assisted solenoid control of directional control valves, use of relay and contactors. Control circuitry for simple single cylinder applications. Compressed air: Production of compressed air – compressors, preparation of compressed air- Driers, Filters, Regulators, Distribution of compressed air- Piping layout.	**14**

TEXT BOOKS:

1. S.R. Majumdar **Oil Hydraulic Systems - Principles and Maintenance**, Tata Mc Graw Hill publishing company Ltd. 2001. ISBN- 10: 0074637487
2. S.R. Majumdar Pneumatic Systems, Tata Mc Graw Hill publishing Co., 1995. ISBN- 0074602314.

REFERENCES BOOKS:

1. Anthony Esposito **Fluid Power with applications**, Fifth edition Pearson education, Inc. 2000. ISBN- 10: 129202387
2. Andrew Parr **Pneumatics and Hydraulics**. Jaico Publishing Co. 2000. ISBN- 10: 0750644192

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)

CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

(Irrespective of portions covered due to whatever might be the reason)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO1	Illustrate and explain the significance hydraulic and pneumatic components.
CO2	Describe the symbolic representations of fluid power components in an industrial circuit.
CO3	Integrate and differentiate a function for given set of tabulated data with greater accuracy for engineering problems.
CO4	Evaluate the selection of valves for specific applications
CO5	Design and develop hydraulic and pneumatic based system for industrial applications.

MAPPING OF COs WITH POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	-	-	-	-	-	-	-	-	-	-
CO2	-	3	2	2	2	-	-	-	-	-	-
CO3	-	-	2	2	-	-	-	-	-	-	-
CO4	3	2	1	-	3	-	1	-	-	-	-

ADMISSION YEAR: 2018-19 **ACADEMIC YEAR: 2019-20**

COURSE TITLE: COMPUTATIONAL METHODS IN ENGINEERING ANALYSIS		
Sub Code: 18MMD334	**No of Credits: L-T-P-SS** **4:0:0:0=4**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**
Pre-requisites	Mom, Design of Machine Elements, Finite Element Method.	

COURSE OBJECTIVES:

The aim of the course is to equip an engineer with skills to develop mathematical models: It is an art of applying mathematics to complex real-world problems. The course combines mathematical theory, practical engineering and scientific computing to address today's technological challenges. It facilitates conversion of scientific statements into a form Engineers understand.

	CONTENTS	Hrss
UNIT-1	**Approximations and Round off Errors:** Significant figures, accuracy and precision, error definitions, round off errors and truncation errors. Mathematical modeling and Engineering problem solving, simple mathematical model, Conservation Laws of Engineering.	08
UNIT-2	**Roots of Equations:** Bracketing Methods-Graphical method, Bisection method, False position method, Newton- Raphson method, Secant Method. Multiple roots, Simple fixed-point iteration. **Roots of Polynomial:** Polynomials in Engineering and Science, Muller's method, Bairstow's Method Graeffe's Roots Squaring Method.	08
UNIT-3	**Numerical Differentiation and Numerical Integration:** Newton –Cotes and Gauss Quadrature Integration formulae, Integration of Equations, Romberg integration, Numerical Differentiation Applied to Engineering problems, High Accuracy differentiation formulae.	08
UNIT-4	**System of Linear Algebraic Equations and Eigen Value Problems:** Introduction, Direct methods, Cramer's Rule, Gauss Elimination Method, Gauss-Jordan Elimination Method, Triangularization method, Cholesky Method, Partition method, Error Analysis for direct methods, Iteration Methods. **Eigen values and Eigen Vectors:** Bounds on Eigen Values, Jacobi method for symmetric matrices, Givens method for symmetric matrices, Rutishauser method for arbitrary matrices, Power method, Inverse power method.	14

UNIT-5	**Linear Transformation:** Introduction to Linear Transformation, The matrix of Linear Transformation, Linear Models in Science and Engineering **Orthogonality and Least Squares**: Inner product, length and orthogonality, orthogonal sets, Orthogonal projections, The Gram-Schmidt process, Least Square problems, Inner product spaces.	**14**

TEXT BOOKS:

3. Steven C. Chapra, Raymond P. Canale **"Numerical Methods for Engineers**"- 5th Edition, Tata McGraw Hill, 2007.
4. S. S. Sastry "**Introductory Method of Numerical Analysis**", PHI, 2009.
5. M K. Jain, S.R.K Iyengar, R K. Jain "**Numerical Methods for Scientific and Engg. Computation**". New Age International, 2003.

REFERENCES BOOKS:

3. Perviz Moin **"Fundamentals of Engineering Numerical Analysis",** Cambridge, 2010.
4. David. C. Lay, **"Linear Algebra and its applications"** -3rd edition, Pearson Education, 2005.
5. Laurence V Fausett, **"Applied Numerical Analysis using Matlab"**, Pearson, 2008.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)
(Irrespective of portions covered due to whatever might be the reason)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO1	Construct and analyze mathematical models of physical applications.
CO2	Find the roots of polynomials, algebraic, transcendental or simultaneous system of equations in science and engineering problems.
CO3	Integrate and differentiate a function for given set of tabulated data with greater accuracy for engineering problems.
CO4	Solve system of linear algebraic equations and compute eigen values and eigen vectors of matrices.
CO5	Demonstrate use of computational tools like MAT Lab to obtain solution to complex mathematical models.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	2	-	-	-	2	-	3	-	-	-	-	-
CO2	2	3	3	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-
CO4	3	3	2	-	-	-	-	1	-	-	-	-

INTERNSHIP-18MMDI34

Internship: The student shall undergo internship for 16 weeks.

Preliminary Report submission and Evaluation after 8th week of Internship to be carried out by the Internal Guide of the college and a senior faculty for 100 marks

Final Report submission and Evaluation after 16th week of Internship to be carried out by the Internal Guide of the college and a senior faculty of Dept. Report Evaluation to be completed within two weeks of submission for 100 marks.

Viva-Voce on Internship - To be conducted by the Internship Guide (from the college) and the External Guide / Examiner within 2 weeks of Submission with a senior faculty / HoD as chairman for 100 marks

COURSE TITLE: Modelling & Analysis Lab		
Sub Code: 18MMDL35	**No of Credits: L-T-P-SS** **1:0:3:0=4**	**No. of Lecture hours/week :03**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**
Pre-requisites	Design and vibration knowledge.	

Note:

1) These are independent laboratory exercises
2) A student may be given one or two problems stated herein
3) Student must submit a comprehensive report on the problem solved and give a Presentation on the same for Internal Evaluation
4) Any one of the exercises done from the following list has to be asked in the Examination for evaluation.

Course Content:

Experiment #1 Structural Analysis

Part A: FE Modeling of a stiffened Panel using a commercial preprocessor.

Part B: Buckling, Bending and Modal analysis of stiffened Panels.

Part C: Parametric Studies.

Experiment #2 Design Optimization

Part A: Shape Optimization of a rotating annular disk.

Part B: Weight Minimization of a Rail Car Suspension Spring.

Part C: Topology Optimization of a Bracket.

Experiment #3 Thermal analysis

Part A: Square Plate with Temperature Prescribed on one edge and Opposite edge insulated.

Part B: A Thick Square Plate with the Top Surface exposed to a Fluid at high temperature, Bottom Surface at room temperature, Lateral Surfaces Insulated.

Experiment #4 Thermal Stress Analysis

Part A: A Thick-Walled Cylinder with specified Temperature at inner and outer Surfaces.

Part B: A Thick-Walled Cylinder filled with a Fluid at high temperature and Outer Surface exposed to atmosphere.

Experiment#5 CFD Analysis

Part A: CFD Analysis of a Hydro Dynamic Bearing using commercial code.

Part B: Comparison of predicted Pressure and Velocity distributions with Target solutions.

Part C: Experimental Investigations using a Journal Bearing Test Rig.

Part D: Correlation Studies.

Experiment #6 Welded Joints.

Part A: Fabrication and Testing.

Part B: FE Modeling and Failure Analysis.

Experiment #7 Bolted Joints.

Part A: Fabrication and Testing.

Part B: FE Modeling and Failure Analysis.

Part C: Correlation Studies.

Experiment #8 Adhesive Bonded Joints.

Part A: Fabrication and Testing.

Part B: FE Modeling and Failure Analysis.

Part C: Correlation Studies.

Course Outcomes:

Upon completion of this course, the student will be able to

CO1	Acquire knowledge of stresses, strains and failure theories and analyze them in terms of mathematical models.
CO2	Design and conduct experiments involving photo elasticity and strain gauges.
CO3	Apply Experimental techniques for different engineering problems.
CO4	Use Finite element analysis software and make comparison with other techniques.

COURSE TITLE: TECHANICAL SEMINAR		
Sub Code: 18MMDS36	**No of Credits: L-T-P-SS** **0:0:2:0=2**	**No. of Lecture hours/week :02**
CIE Marks: 50		

Course Outcomes:

Upon completion of this course, the student will be able to

CO1	Identify and understand current trends and real-world issues related to topics in Machine Design.
CO2	Classify appropriate content and sources, through literature survey, that can be summarized and integrated into presentation
CO3	Review, analyze, and interpret data & results using critical thinking skills
CO4	Revise and present scientific case studies in presentation
CO5	Collaborate effectively with other students in analyzing results and preparing oral presentations
CO6	Prepare a technical seminar report and communicate effectively through oral presentation using multimedia tools

III SEMESTER

PROJECT PHASE: I 18MMDP37

Problem formulation and submission of **synopsis** within 8 weeks from the commencement of 3rd semester, which shall be evaluated for 50 marks by the committee constituted for the purpose by the Head of the Department comprising the guide, senior faculty of the department with HoD as Chairman.

Literature survey and progress done after 16 weeks shall be evaluated by guide and external examiner with senior faculty / HoD as chairman for 50 marks.

IV SEMESTER

- **Project Phase-II** - Internal Evaluation of progress in Project work shall be evaluated after 8 weeks for 25 marks by the committee constituted for the purpose by the Head of the Department comprising the guide and senior faculty of the department with HoD as Chairman
- **Project Phase-III** - Internal Evaluation of Project Demonstration, which shall be evaluated after 15 weeks for 25 marks by the committee constituted for the purpose by the Head of the Department.
- **Final Evaluation of Project Work and Viva-voce**.
  - Final evaluation of project to be carried out after 16 weeks from the date of commencement of 4th semester.
  - The Internal Examiner (the project guide with a teaching experience of at least three years) and External Examiner with HoD as chairman will complete the final evaluation of Project.
- Internal and External Examiners shall carry out the evaluation for 100 Marks each and the average of these marks shall be the final marks of the Project Evaluation.
- **Viva – Voce:** The Viva-Voce shall be conducted jointly by Internal Examiner and External Examiner with HoD as chairman for 100 Marks.

DR AMBEDKAR INSTITUTE OF TECHONOLOGY

DEPARTMENT OF MECHNICAL ENGINEERING

SCHEME AND SYLLABUS

FOR

M. Tech MACHINE DESIGN

YEAR 2019-20

PROGRAM EDUCATIONAL OBJECTIVES

PEO1--Graduates will have knowledge in the discipline of Machine Design with hands on skill in using modern engineering tools to address real world engineering problems and be socially responsible.

PEO2– Graduates shall be successful in their career as analysts and designers of structural components of conventional and advanced materials, participating in a team or individually in an industry, research or academia.

PEO3– Graduates shall be proficient in their communication, presentation and will be prepared to engage in the process of life-long learning through professional development and research.

PROGRAM OUTCOMES

PO No.	Program Outcomes (PO)
PO1	Acquire in-depth knowledge of specific discipline or professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.
PO2	Analyze complex engineering problems critically, apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context
PO3	Think laterally and originally, conceptualize and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.
PO4	Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.
PO5	Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of the limitations.
PO6	Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.
PO7	Demonstrate knowledge and understanding of engineering and management principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economic and financial factors.
PO8	Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.
PO9	Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.
PO10	Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.
PO11	Observe and examine critically the outcomes of one's actions and make corrective

BATCH **2019-20** **MACHINE DESIGN**

FIRST SEMSTER			L	T	P	C
1	18MMD11	ADVANCED MECHANICS OF SOLIDS	4	0	0	4.0
2	18MMD12	FINITE ELEMENT METHOD	3	0	2	4.0
3	18MMD131	EXPERIMENTAL MECHANICS	3	0	2	4.0
4	18MMD132	ROBUST DESIGN	4	0	0	
5	18MMD141	DYNAMICS AND MACHINE DESIGN	4	0	0	4.0
6	18MMD142	DESIGN FOR MANUFACTURE	4	0	0	
7	18MMD151	MECHATRONICS SYSTEM DESIGN	4	0	0	4.0
8	18MMD152	AUTOMOBILE SYSTEM DESIGN	4	0	0	
9	18MMD16	INDUSTRIAL VISIT		0	2	2.0
FIRST SEMESTER END CREDITS						22.0

SECOND SEMSTER			L	T	P	C
1	18MMD21	ADVANCED MACHINE DESIGN	4	0	0	4.0
2	18MMD22	ADVANCED THEORY OF VIBRATIONS	3	0	2	4.0
3	18MMD231	TRIBOLOGY AND BEARING DESIGN	4	0	0	4.0
4	18MMD232	DESIGN OPTIMIZATION	4	0	0	
5	18MMD241	COMPOSITE MATERIALS TECHONOLOGY	4	0	0	4.0
6	18MMD242	FINITE ELEMENT METHODS FOR HEAT TRANSFER	4	0	0	
7	18MMD251	THEORY OF PLASTICITY	4	0	0	4.0
8	18MMD252	ROTOR DYNAMICS	4	0	0	
9	RM27	RESEARCH METHODOLOGY	2	0	0	2.0
SECOND SEMESTER END CREDITS						22.0
FIRST YEAR CREDITS						44.0
CUMULATIVE CREDITS AT END OF 1st YEAR						44.0

BATCH **2019-20** **MACHINE DESIGN**

THIRD SEMSTER			L	T	P	C
1	18MMD31	FRACTURE MECHANICS	3	0	0	3.0
2	18MMD32X	ELECTIVE -1	3	0	0	3.0
3	18MMD33X	ELECTIVE -2	3	0	0	3.0
4	18MMDI34	INTERNSHIP	0	0	6	6.0
5	18MMDL35	MODELING AND ANALYSIS LAB	0	0	2	2.0
6	18MMDS36	TECHNICAL SEMINAR	0	0	1	1.0
7	18MMDP37	PROJECT PHASE -1	0	2	0	2.0
THIRD SEMESTER END CREDITS						20.0

ELECTIVE 1			ELECTIVE-2		
SL.NO	NAME OF THE SUBJECT	Subject code	SL.NO	NAME OF THE SUBJECT	Subject Code
1	SMART MATERIALS AND STRUCTURES	18MMD321	1	COMPUTER APPLICATIONS IN DESIGN	18MMD331
2	STATISTICAL MODELLING& EXPERIMENTAL DESIGN	18MMD322	2	ADVANCE SYSTEM DESIGN	18MMD332
3	OPTIMIZATION TECHNIQUES	18MMD323	3	DESIGN OF HYDRAULICS AND PNEUMATICS	18MMD333
4	THEORY OF PLATES AND SHELLS	18MMD324	4	COMPUTATIONAL METHODS IN ENGINEERING ANALYSIS	18MMD334

FOURTH SEMSTER			L	T	P	C
1	18MMDP41	PROJECT WORK PHASE II – MIDTERM INTERNAL EVALUATION	0	0	2	2.0
2	18MMDP42	PROJECT WORK EVALUATION AND VIVA VOCE	0	0	22	22
FOURTH SEMESTER END CREDITS						24.0
SECOND YEAR CREDITS						44.0
CUMULATIVE CREDITS AT END OF 2nd YEAR						88.0

1^{ST} SEMESTER

ADMISSION YEAR:2019-20 **ACADEMIC YEAR: 2019-20**

COURSE TITLE: ADVANCED MECHANICS OF SOLIDS		
Sub Code:18MMD11	**No of Credits: L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week: 04**
Exam Duration: 3 hours	**CIE Marks: 50**	**Exam Marks: 50**
Pre-requisites	**MOM, DESIGN OF MACHINE ELEMENTS.**	

COURSE OBJECTIVES:

To study the basic concept of stresses, stress distribution, elastic constants when the material is subjected to loading within the elastic limits. Study the stress distribution in plane, polar and cylindrical coordinate systems. Analyze the material or component subjected to torsion of circular and non-circular shafts (elliptical, triangular bars) Study the thermo-elastic properties of the material at elevated temperatures.

#	CONTENTS	Hrs
UNIT-1	**INTRODUCTION TO STRESS:** Definition and Notation for forces and stresses. Components of stresses, equations of Equilibrium, Specification of stress at a point. Principal stresses and shear stresses and Mohr's diagram in three dimensions. Boundary conditions. Stress transformation, Stress components on an arbitrary plane, Stress invariants, Octahedral stresses, Decomposition of state of stress.	10
UNIT-2	**INTRODUCTION TO STRAIN**: Deformation, Strain Displacement relations, Strain components, The state of strain at a point, Principal strain, Strain transformation, Compatibility equations, Cubical dilatation. **STRESS-STRAIN RELATIONS AND THE GENERAL EQUATIONS OF ELASTICITY**: Generalized Hooke's; law in terms of engineering constants. Formulation of elasticity Problems. Existence and uniqueness of solution, Saint -Venant's principle, Principle of super position and reciprocal theorem.	10
UNIT-3	**ENERGY METHODS**: Work done by forces and elastic strain energy stored, Begg's Deformeter, First theorem of Castigliano, Theorem of virtual work, Kirchhoff's theorem.	10
UNIT-4	**TWO DIMENSIONAL PROBLEMS IN CARTESIAN CO-ORDINATES:** Airy's stress function, investigation for simple beam problems. Bending of a narrow cantilever beam under end load, simply supported beam with uniform load, Use of Fourier series to solve two dimensional problems. **TORSION OF PRISMATIC BARS:** Torsion of Circular and elliptical cross section bars, Membrane analogy, Torsion of thin-walled closed tubes.	12

UNIT-5	**TWO DIMENSIONAL PROBLEMS IN POLAR CO-ORDINATES:** General equations, stress distribution symmetrical about an axis, thick cylinder, shrink fit, Strain components in polar co-ordinates, Rotating disk and cylinder, Thermal stresses in thin discs, Stress concentration around a circular hole in an infinite plate. Thermo-elastic stress –strain relations.	10

TEXT BOOKS:

1. **Advanced Mechanics of solids**, L. S. Srinath, Tata Mc. Graw Hill, 2003
2. **Theory of Elasticity,** S. P. Timoshenko and J. N Gordier, McGraw Hill International, 3rd edition, 1972

REFERENCES BOOKS:

1. **Theory of Elasticity,** Dr. Sadhu Singh, Khanna Publications, 1988
2. **Elasticity, Theory, Applications &Numericals,** Martin H Sadd, Elsevier. 2005
3. **Applied Elasticity,** Seetharaman & Govindaraju, Interline Publishing
4. **Applied Elasticity,** C.T. WANG Sc. D. Mc. Graw Hill Book Co.1953.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)
(Irrespective of portions covered due to whatever might be the reason)

QUESTION PAPER PATTERN (SEE)

Q. No	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**
Unit	**1**		**2**		**3**		**4**		**5**	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO1	Apply basic concepts in continuum mechanics of solids viz. Stress and strain tensors, equilibrium, compatibility and constitutive equations and methods of solution to elasticity problems
CO 2	Evaluate stresses and displacements in simple solids such as pressurized cylinders, shrink fitted cylinders, rotating disc and shaft, plate with hole and non-circular shafts and thin tubes under torsion.
CO 3	Use MATLAB or equivalent software to evaluate and plot particular solutions.
CO 4	Apply the principles of plastic deformation to estimate yielding in simple engineering structures.

CO 5	Apply principles of continuum mechanics to design a structure or component to achieve desired performance under realistic constraints.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	2	2	3	3	2	3	3	1	2
CO2	2	3	3	2	2	1	3	2	3	3	3	2
CO3	3	3	3	2	3	2	3	1	3	2	3	2
CO4	3	3	2	2	3	2	3	1	2	2	3	3

ADMISSION YEAR :2019-20 **ACADEMIC YEAR: 2019-20**

COURSE TITLE: FINITE ELEMENT METHOD		
Sub Code:18MMD12	**No of Credits: L-T-P-SS 3:0:0:1 =4**	**No. of lecture hours/week: 04**
Exam Duration: 3 hours	**CIE Marks: 50**	**Exam Marks: 50**
Pre-requisites	**Engineering Mechanics, Design of Machine Elements**	

COURSE OBJECTIVES:

This course enables the student to identify failure modes and evolve design by analysis methodology. Design against fatigue failure is given explicit attention. **To** impart structures analysis for stress, strain & dynamic loading knowledge. To enable formulation of the design problems into FEA. To comprehend the basic concepts and enhance capabilities for solving complex problems. To introduce the concepts of elastic and static analysis problems.

#	CONTENTS	Hrs
UNIT-1	**MATHEMATICS FOR FEM**: Significant figures, accuracy and precision, error definitions, round off errors and truncation errors. Mathematical modeling. **SYSTEM OF LINEAR ALGEBRAIC EQUATIONS AND EIGEN VALUE PROBLEMS:** Gauss Elimination Method, Gauss-Jordan Elimination Method, Triangularization method, Cholesky Method, Partition method, Iteration Methods. Eigen values and Eigen Vectors: Bounds on Eigen Values, Jacobi method for symmetric matrices.	10
UNIT-2	**Introduction to Finite Element Method:** Basic Steps in Finite Element Method to solve mechanical engineering (Solid, Fluid and Heat Transfer) Galerkin approach, Displacement Approach: Admissible Functions, Convergence Criteria: Conforming and Non-Conforming elements, C_o C_1 and C_n Continuity Elements. Basic Equations, Element Characteristic Equations, Assembly Procedure, Boundary and Constraint Conditions	10
UNIT-3	**Solid Mechanics: One-Dimensional Finite Element Formulations and Analysis** – Bars-uniform, varying and stepped cross section-Basic (Linear) and Higher Order Elements Formulations for Axial, Torsional and Temperature Loads with problems. Beams- Basic (Linear) Element Formulation-for uniform, varying and stepped cross section- for different loading and boundary conditions with problems.	10
UNIT-4	**FINITE ELEMENT FORMULATIONS FOR STRUCTURAL MECHANICS PROBLEMS:** Basics of plates and shell theories: Classical thin plate Theory, Shear deformation Theory and Thick Plate theory. Finite Element Formulations for triangular and quadrilateral Plate elements. Finite element formulation of flat, curved, cylindrical and conical Shell elements **TWO-DIMENSIONAL FINITE ELEMENT FORMULATIONS FOR SOLID MECHANICS PROBLEMS**: Triangular Membrane (TRIA 3, TRIA 6, TRIA 10) Element, Four-Noded Quadrilateral Membrane (QUAD 4, QUAD 8) Element Formulations for in-plane loading with sample problems. Triangular and Quadrilateral, Axis-symmetric basic and higher order Elements formulation for axis-symmetric loading only with sample	12

	problems.	
UNIT-5	**THREE-DIMENSIONAL FINITE ELEMENT FORMULATIONS FOR SOLID MECHANICS PROBLEMS:** Finite Element Formulation of Tetrahedral Element (TET 4, TET 10), Hexahedral Element (HEXA 8, HEXA 20), for different loading conditions. Serendipity and Lagrange family Elements. **DYNAMIC ANALYSIS:** Finite Element Formulation for point/lumped mass and distributed masses system, Finite Element Formulation of one-dimensional dynamic analysis: bar, truss, frame and beam element. Finite Element Formulation of Two-dimensional dynamic analysis: triangular membrane and axisymmetric element, quadrilateral membrane and axisymmetric element. Evaluation of eigen values and eigen vectors applicable to bars, shaft, beams, plane and space frame.	10

Text Books:

1. **S.S. SASTRY**, Introductory Methods of Numerical Analysis, PHI, 2005.
2. **STEVEN C. CHAPRA, RAYMOND P. CANALE**, Numerical Methods for Engineers, Tata McGraw Hill, 4th Ed, 2002.
3. **M K JAIN, S.R.K IYENGAR, R K. JAIN**, Numerical methods for Scientific and engg computation, New Age International, 2003.
4. **T. R. CHANDRUPATLA AND A. D. BELEGUNDU**, Introduction to Finite Elements in Engineering, Prentice Hall, 3rd Ed, 2002.
5. **LAKSHMINARAYANA H. V.**, Finite Elements Analysis– Procedures in Engineering, Universities Press, 2004.

Reference Books:

1. **RAO S. S.**, Finite Elements Method in Engineering- 4th Edition, Elsevier, 2006
2. **P. SESHU**, Textbook of Finite Element Analysis, PHI, 2004.
3. **BATHE K. J**., Finite Element Procedures, Prentice-Hall, 2006.
4. **COOK R. D.**, Finite Element Modeling for Stress Analysis, Wiley,1995.
5. **DAVID. C. LAY**, Linear Algebra and its applications, 3rd edition, Pearson Education, 2002

SYLLABUS COVERAGE FOR CIE-1, 2, 3
CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (Firs100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**
Unit	**1**		**2**		**3**		**4**		**5**	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.

2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

<u>COURSE OUTCOMES:</u> Learners will able to

CO1	Model some simple mathematical models of physical Applications. Develop governing equation for a mechanical system and apply principles of variation and integral formulation to formulate finite element equations.
CO2	Formulate and perform one dimensional, two-dimensional structural analysis using bar, beam, triangular and quadrilateral elements.
CO3	Formulate axisymmetric triangular element and analyze problems on solids of revolution.
CO4	Formulate mass matrices and compute eigen values and eigen vectors for a 1- D and 2D analysis of mechanical system.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	2	2	3	3	2	3	3	1	2
CO2	2	3	3	2	2	1	3	2	3	3	3	2
CO3	3	3	3	2	3	2	3	1	3	2	3	2
CO4	3	3	2	2	3	2	3	1	2	2	3	3

ADMISSION YEAR :2019-20 **ACADEMIC YEAR: 2019-20**

EXPERIMENTAL MECHANICS

Course Code	**:**	**18MMD131**		**CIE Marks**	**:**	**50**
Hrs./Week	**:**	**L: T: P: 3:1:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:
This course aims at a comprehensive study of mechanics of solids. The objective of this course is to familiarize the student with state-of-the-art experimental techniques namely strain gauges, photo elasticity, moiré interferometry, brittle coating, moiré fringes and holography.

Course Content: Chapters/ Units

1. **Introduction**: Definition of terms, calibration, standards, dimension and units, generalized measurement system, Basic concepts in dynamic measurements, system response, distortion, impedance matching, experiment planning.
   Analysis of Experimental Data: Cause and types of experimental errors, error analysis. Statistical analysis of experimental data- Probability distribution, gaussian, normal distribution. **10 Hours**

2. **Force, Torque and Strain Measurement:** Mass balance measurement, Elastic Element for force measurement, torque measurement. Strain Gages -Strain sensitivity of gage metals, Gage construction, Gage sensitivity and gage factor, Performance characteristics, Environmental effects Strain, gage circuits, Potentiometer, Wheat Stone's bridges, Constant current circuits. Strain Analysis Methods-Two element and three element, rectangular and delta rosettes, Correction for transverse strains effects, stress gage - plane shear gage, Stress intensity factor gage. **10 Hours**

3. **Stress Analysis:** Two-Dimensional Photo elasticity **-** Nature of light, - wave theory of light, - optical interference - Polariscopes stress optic law - effect of stressed model in plane and circular Polariscopes, Isoclinic, isochromatic fringe order determination. Calibration Photo elastic model materials. Model to prototype scaling**.** . **10 Hours**

4. **Three-Dimensional Photo elasticity:** Stress freezing method, General slice, Effective stresses, Stresses separation, Shear deference method, Oblique incidence method Secondary principal stresses, Scattered light photo elasticity, Principals, Polari scope and stress data analyses**.**
   Holography: Introduction, Equation for plane waves and spherical waves, Intensity, Coherence, Spherical radiator as an object (record process), Hurter, Driffield curves, Reconstruction process, Holographic interferometry, Realtime. and double exposure methods, Displacement measurement, Isopaches **10 Hours**

5. **Coating Methods:** a) Photo elastic Coating Method-Birefringence coating techniques Sensitivity Reinforcing and thickness effects - data reduction - Stress separation techniques Photo elastic strain gauges. b) Brittle Coatings Method: Brittle coating technique Principles data analysis - coating materials, Coating techniques. c) Moire Technique - Geometrical approach, Displacement approach-sensitivity of Moire data reduction, In plane and out plane Moire methods, Moire photography, Moire grid production. **12 Hours**

NOTE: the students are advised to prepare the lab report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. **Holman,** "Experimental Methods for Engineers" 7thEdition, Tata McGraw-Hill Companies, Inc, New York, 2007.
2. **R. S. Sirohi, H. C. Radha Krishna,** "Mechanical measurements" New Age International Pvt. Ltd., New Delhi, 2004
3. **Experimental Stress Analysis** - Srinath, Lingaiah, Raghavan, Gargesa, Ramachandra and Pant, Tata McGraw Hill, 1984.
4. **Instrumentation, Measurement and Analysis -**Nakra & Chaudhry, B C Nakra K Chaudhry, Tata McGraw-Hill Companies, Inc, New York, Seventh Edition, 2006.

Reference Books:

1. **Measurement Systems Application and Design** - Doeblin E. A., 4th (S.I.) Edition, McGraw Hill, New York. 1989
2. **Design and Analysis of Experiments -** Montgomery D.C., John Wiley & Sons, 1997.
3. **Experimental Stress Analysis** - Dally and Riley, McGraw Hill, 1991.
4. **Experimental Stress Analysis -** Sadhu Singh, Khanna publisher, 1990.
5. **Photoelasticity Vol I and Vol II -** M.M.Frocht,. John Wiley and sons, 1969.
6. **Strain Gauge Primer -** Perry and Lissner, McGraw Hill, 1962.

Course Outcomes:

Upon completion of this course, the student will be able to

CO1	Understand functional requirements of a generalized measurement system and identify suitable components for an application.
CO2	Use concepts of Data Acquisition, Processing and apply the same for interpretation and analysis of experimental data.
CO3	Determine stresses and strains in a structure using different methods such as strain gages, photo-elasticity, brittle coating and holography.
CO4	Identify and apply suitable experimental stress analysis to practical problems

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (Firs100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Unit	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	2	2	3	3	2	3	3	1	2
CO2	2	3	3	2	2	1	3	2	3	3	3	2
CO3	3	3	3	2	3	2	3	1	3	2	3	2
CO4	3	3	2	2	3	2	3	1	2	2	3	3

ADMISSION YEAR :2019-20 **ACADEMIC YEAR: 2019-20**

ROBUST DESIGN

Sub Code: 18MMD132	**No of Credits: L-T-P-SS 4:0:0:0=4**	**No. of lecture hours/week :04**
Exam Duration: 3 hours	**CIE Marks: 50**	**Exam Marks :50**
Pre-requisites	Mom, Design of Machine Elements**.**	

COURSE OBJECTIVES:
To study the basic concept of stresses, stress distribution, elastic constants when the material is subjected to loading within the elastic limits.

#	CONTENTS	Hrs
UNIT-1	**QUALITY BY EXPERIMENTAL DESIGN**: Quality, western and Taguchi quality philosophy, Elements of cost, Noise factors causes of variation, Quadratic loss function and variation of quadratic loss functions. **ROBUST DESIGN:** Steps in robust design: parameter design and tolerance design, reliability improvement through experiments, illustration through numerical examples.	10
UNIT-2	**EXPERIMENTAL DESIGN:** Classical experiments: factorial experiments, terminology, factors. Levels, Interactions, Treatment combination, randomization, 2-level experimental design for two factors and three factors. 3-level experiment deigns for two factors and three factors, factor effects, factor interactions, Fractional factorial design, Saturated design, Central composite designs, Illustration through numerical examples.	10
UNIT-3	**Measures of Variability:** Measures of variability, Concept of confidence level, Statistical distributions: normal, log normal and Weibull distributions. Hypothesis testing, Probability plots, choice of sample size illustration through numerical examples. Analysis and interpretation of experimental data: Measures of variability, Ranking method, column effect method and plotting method, Analysis of variance (ANOVA), in factorial experiments: YATE's algorithm for ANOVA, Regression analysis, Mathematical models from experimental data, illustration through numerical examples.	10
UNIT-4	**TAGUCHI'S ORTHOGONAL ARRAYS:** Types orthogonal arrays, Selection of standard orthogonal arrays, Linear graphs and interaction assignment, dummy level technique, Compound factor method, modification of linear graphs, Column merging method, branching design, Strategies for constructing orthogonal arrays. Signal to Noise ratio (S-N Ratios): Evaluation of sensitivity to noise, Signal to noise ratios for static problems, Smaller – the – better types, Nominal – the –better – type, larger – the better – type. Signal to noise ratios for dynamic problems, Illustrations through numerical examples.	12
UNIT-5	**PARAMETER DESIGN AND TOLERANCE DESIGN:** Parameter and tolerance design concepts, Taguchi's inner and outer arrays, Parameter design strategy, Tolerance deign strategy, Illustrations through numerical examples. **RELIABILITY IMPROVEMENT THROUGH ROBUST DESIGN**: Role of S-N ratios in reliability improvement; Case study; illustrating the reliability improvement of routing process of a printed wiring board using robust design concepts.	**10**

Text Books:

1.**Madhav S. Phadake,** “Quality Engineering using Robust Design”, Prentice Hall,1989.

2.**Douglas Montgomery,** “Design and analysis of experiment”, Willey India Pvt. Ltd.,2007.

3.**Phillip J. Ross, Taguchi**, “Techniques for Quality Engineering” McGraw Hill Int.Ed.,1996.

Reference Books:

1. **Thomas B. Barker,** “Quality by Experimental Design” , Marcel Dekker IncASQC Quality Press,1985.
2. **C.F. Jeff Wu**, ichael Hamada, “Experiments planning, analysis and parameter design optimization”, John Wiley Ed., 2002.
3. **W.L. Condra, Marcel Dekker**, “Reliability improvement by Experiments”, Marcel Dekker Inc ASQC Quality Press, 1985.

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (Firs100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**
Unit	**1**		**2**		**3**		**4**		**5**	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

COURSE OUTCOMES:

Learners will able to

CO1	Apply Design of Experiments (DOE) techniques to various methods of design.
CO 2	Analyze and evaluate design parameters using different design strategies.
CO 3	Illustrate through numerical examples improvements in design parameters.
CO 4	Perform case studies involving identification of parameters, analysis of experimental data in a robust design.

MAPPING OF COs WITH Pos

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	2	2	3	3	2	3	3	1	2
CO2	2	3	3	2	2	1	3	2	3	3	3	2
CO3	3	3	3	2	3	2	3	1	3	2	3	2
CO4	3	3	2	2	3	2	3	1	2	2	3	3

ADMISSION YEAR :2019-20 **ACADEMIC YEAR: 2019-20**

COURSE TITLE: ADVANCED DESIGN OF MECHANISM		
Sub Code: 18MMD141	**No of Credits: L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week: 04**
Exam Duration: 3 hours	**CIE Marks: 50**	**Exam Marks: 100**
Pre-requisites	**Engineering mechanics, MOM, Material science and metallurgy**	

COURSE OBJECTIVES:

To include dynamics considerations in the design of mechanisms for engineering applications is the objective of this course. To study basic principles of machine design. To acquaint with the concepts of strength design related to various components. To familiarize with use of design data books & various codes of practice. To make conversant with preparation of working drawings based on designs and enable the students to have high ethical standards in terms of team work to be a good design engineer

#	CONTENTS	Hrs
UNIT-1	**GEOMETRY OF MOTION:** Introduction, analysis and synthesis, Mechanism terminology, planar, Spherical and spatial mechanisms, mobility, Grashoffs law, Equivalent mechanisms, Unique mechanisms, Kinematic analysis of plane mechanisms: Auxiliary point method using rotated velocity vector, Hall - Ault auxiliary point method, Goodman's indirect method.	10
UNIT-2	**GENERALIZED PRINCIPLES OF DYNAMICS:** Virtual work, principle of virtual work, Equilibrium and stability, Kinetic energy of a system, Angular momentum, Generalized momentum. Lagrange's Equation: Lagrange's equation from D'Alembert's principles, Examples, Hamilton's equations, Hamilton's principle, Lagrange's, equation from Hamilton's principle, Derivation of Hamilton's equations, Examples.	10
UNIT-3	**SPATIAL MECHANISMS**: Introduction, Position analysis problem, Velocity and acceleration analysis, Eulerian angles.	10
UNIT-4	**SYSTEM DYNAMICS:** Gyroscopic action in machines, Euler's equation of motion, Phase Plane representation, Phase plane Analysis, Response of Linear Systems to transient disturbances. Synthesis of Linkages: Type, number, and dimensional synthesis, Function generation, Path generation and Body guidance, Precision positions, Structural error, Chebyshev spacing, two position synthesis of slider crank mechanisms, Crank-rocker mechanisms with optimum transmission angle Motion Generation: Poles and relative poles, Location of poles and relative poles, pooled, Curvature, Inflection circle.	12
UNIT-5	**GRAPHICAL METHODS OF DIMENSIONAL SYNTHESIS:** Two position synthesis of crank and rocker mechanisms, three position synthesis, four position synthesis (point precision reduction) Overlay method, Coupler curve synthesis, Cognate linkages. Ana1ytical Methods of Dimensional Synthesis: Freudenstein's equation for four bar mechanism and slider crank mechanism, Examples, Bloch's method of synthesis, Analytical synthesis using complex algebra.	10

Text Books:

1. **GREENWOOD,** "Classical Dynamics", Prentice Hall of India, 1988.
2. **K.J. Waldron & G.L. Kinzel, "Kinematics, Dynamics and Design of Machinery",** Wiley India, 2007.

References Books:

1. **J E SHIGLEY**, "Theory of Machines and Mechanism" -McGraw-Hill, 1995
2. **A.G. AMBEKAR,** "Mechanism and Machine Theory", PHI, 2007.
3. **GHOSH AND MALLICK**, "Theory of Mechanism and Mechan ism", East West press 2007.
4. **DAVID H. MYSZKA,** "Machines and Mechanisms", Pearson Education, 2005.

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (Firs100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**
Unit	**1**		**2**		**3**		**4**		**5**	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

COURSE OUTCOMES: Learners will able to

CO1	The knowledge of dynamics considerations in mechanism design is essential to use commercial multi body dynamics software in mechanical engineering design.
CO2	Carry out mobility analysis of mechanism and perform velocity and acceleration of complex planer mechanism.
CO3	Synthesize mechanisms for function generation and path generation.
CO4	Analyze the Dynamics of Mechanical systems using D'Alembert's, Lagrange's, and Hamilton's Principles.
CO5	Demonstrate the skills to use software to analyze mechanisms, synthesis of linkages.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	3	2	2	3	2	3	1	3	3
CO2	2	3	3	2	3	3	3	1	2	3	3	2
CO3	3	3	2	3	3	3	1	3	3	2	3	2
CO4	3	3	2	3	3	2	3	2	1	2	3	3

ADMISSION YEAR :2019-20 **ACADEMIC YEAR: 2019-20**

COURSE TITLE: DESIGN FOR MANUFACTURE		
Sub Code: 18MMD142	**No of Credits: L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week: 04**
Exam Duration: 3 hours	**CIE Marks: 50**	**Exam Marks: 50**
Pre-requisites	**metrology & Measurements, Design Of Machine Elements.**	

COURSE OBJECTIVES:

To educate students a clear understanding of factors to be considered in designing parts and components with focus on manufacturability**.** To study Effect of material properties on mechanical design. To acquaint with the concepts of Tolerance. To Design the components with casting consideration. Emphasis on various types of limit gauges for both hole and shaft.

#	CONTENTS	Hrs
UNIT-1	**EFFECT OF MATERIALS AND MANUFACTURING PROCESS ON DESIGN:** Major phases of design. Effect of material properties on design, Effect of manufacturing processes on design. Material selection process cost per unit property, Weighted properties and limits on properties methods.	10
UNIT-2	**TRUE POSITIONAL THEORY:** Comparison between co-ordinate and convention method of feature location. Tolerance and true positioning tolerance virtual size concept, Floating and fixed fasteners. Projected tolerance zone. Assembly with gasket, zero position tolerance. Functional gauges, Paper layout gauging.	10
UNIT-3	**SELECTIVE ASSEMBLY:** interchangeable part manufacture and selective assembly, deciding the number of groups -model-1: group tolerance of mating parts equal, model total and group tolerances of shaft equal. control of axial play-introducing secondary machining operations, laminated shims, examples. Datum features: functional datum, datum for manufacturing, changing the datum. examples	10
UNIT-4	**DESIGN CONSIDERATIONS:** Design of components with casting consideration. Pattern, Mould, and Parting line. Cored holes and Machined holes. Identifying the possible and probable parting line. Casting requiring special sand cores. Designing to obviate sand cores. Component Design: Component design with machining considerations link design for turning components-milling, Drilling and other related processes including finish-machining operations.	12
UNIT-5	**Design of Gauges:** Design of gauges for checking components in assemble with emphasis on various types of limit gauges for both hole and shaft. **TOLERANCE ANALYSIS:** Process capability, mean, variance, skewness, kurtosis, Process capability metrics, Cp, Cpk, Cost aspects, Feature tolerances, Geometries tolerances, Geometric tolerances, Surface finish, Review of relationship between attainable tolerance grades and different machining process. Cumulative effect of tolerance- Sure fit law and truncated normal law.	10

Text Books:

1**. HARRY PECK**, “Designing for Manufacturing”, Pitman Publications, 1983.

2. **DIETER,** “Machine Design” - McGraw-Hill Higher Education, -2008.

3. **R.K. JAIN**, "Engineering Metrology", Khanna Publishers, 1986.

4. **GEOFFREY BOOTHROYD, PETER DEWHURST, WINSTON KNIGHT**, “Product design for manufacture and assembly”, Merce Dekker. Inc. CRC Press, Third Edition

5. **MATERIAL SELECTION AND DESIGN**, Vol. 20 - ASM Hand book.

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (First100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**
Unit	**1**		**2**		**3**		**4**		**5**	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

COURSE OUTCOMES:

Upon completion of this course, the student will be able to

CO1	Understand the role of manufacture and assembly in development of mechanical parts and their assemblies.
CO2	Apply manufacturing considerations in the design and development of components made of casting and machining.
CO3	Apply geometrical dimensioning and tolerances issues in mechanical design.

MAPPING OF COs WITH POs

COs/POs	**po1**	**po2**	**po3**	**po4**	**po5**	**po6**	**po7**	**po8**	**po9**	**po10**	**po11**	**po12**
CO1	3	3	3	3	2	2	3	2	3	1	3	3
CO2	2	3	3	2	3	3	3	1	2	3	3	2
CO3	3	3	2	3	3	3	1	3	3	2	3	2
CO4	3	3	2	3	3	2	3	2	1	2	3	3

ADMISSION YEAR :2019-20 **ACADEMIC YEAR: 2019-20**

COURSE TITLE: MECHATRONICS SYSTEMS DESIGN		
Sub Code: 18MMD151	**No of Credits: L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week: 04**
Exam Duration: 3 hours	**CIE Marks: 50**	**Exam Marks: 50**
Pre-requisites	BASIC ELECTRONICS, BASIC ELECTRICALS, MATERIAL SCIENCE AND METROLOGY	

COURSE OBJECTIVES:

To educate the student regarding integration of mechanical, electronic, electrical and computer systems in the design of CNC machine tools, Robots etc. To provide students with an understanding of the Mechatronic Design Process, actuators, Sensors, transducers, Signal Conditioning, MEMS and Microsystems and also the Advanced Applications in Mechatronics

#	CONTENTS	Hrs
UNIT-1	**Introduction:** Definition and Introduction to Mechatronic Systems. Modeling &Simulation of Physical systems Overview of Mechatronic Products and their functioning, measurement systems. Control Systems, simple Controllers.	10
UNIT-2	**Study of Sensors and Transducers:** Pneumatic and Hydraulic Systems, Mechanical Actuation System, Electrical Actual Systems, Real time interfacing and Hardware components for Mechatronics.	10
UNIT-3	**Electrical Actuation Systems:** Electrical systems, Mechanical switches, Solid state switches, solenoids, DC & AC motors, Stepper motors. **System Models:** Mathematical models: - mechanical system building blocks, electrical system building blocks, thermal system building blocks, electromechanical systems, hydro-mechanical systems, pneumatic systems.	10
UNIT-4	**Signal Conditioning:** Signal conditioning, the operational amplifier, Protection, Filtering, Wheatstone Bridge, Digital signals, Multiplexers, Data Acquisition, Introduction to digital system processing, pulse-modulation. **MEMS and Microsystems:** Introduction, Working Principle, Materials for MEMS and Microsystems, Micro System fabrication process, Overview of Micro Manufacturing, Micro system Design, and Micro system Packaging.	12
UNIT-5	**Data Presentation Systems:** Basic System Models, System Models, Dynamic Response of system. **Advanced Applications in Mechatronics:** Fault Finding, Design, Arrangements and Practical Case Studies, Design for manufacturing, User-friendly design	10

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. W. Bolton, “Mechatronics” - Addison Wesley Longman Publication, 1999
2. HSU “MEMS and Microsystems design and manufacture”- Tata McGraw-Hill Education, 2002

Reference Books:

1. Kamm, “Understanding Electro-Mechanical Engineering an Introduction to Mechatronics”- IEEE Press, 1 edition ,1996
2. Shetty and Kolk “Mechatronics System Design”- Cengage Learning, 2010
3. Mahalik “Mechatronics”- Tata McGraw-Hill Education, 2003
4. HMT “Mechatronics”- Tata McGraw-Hill Education, 199 8
5. Michel.B. Histand& David. Alciatore, “Introduction to Mechatronics & Measurement Systems”–. Mc Graw Hill, 2002
6. “Fine Mechanics and Precision Instruments”- Pergamon Press, 1971.

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (First100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Unit	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

Course Outcome:

At the completion of this course, students will be able to:

CO1	Appreciate multi-disciplinary nature of modern engineering systems.
CO2	Model and analyze mechanical and electrical systems and their connection.
CO3	Be able to integrate mechanical, electronics, control and computer engineering in the design of mechatronics systems.
CO4	Address issues of design, fabrication, and packaging issues of Microsystems.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	3	2	2	3	2	3	1	3	3
CO2	2	3	3	2	3	3	3	1	2	3	3	2
CO3	3	3	2	3	3	3	1	3	3	2	3	2
CO4	3	3	2	3	3	2	3	2	1	2	3	3

AUTOMOBILE SYSTEM DESIGN

Course Code	:	18MMD152		**CIE Marks**	:	**50**
Hrs./Week	:	**L: T: P: 4:0:0**		**SEE Marks**	:	**50**
Credits	:	**04**		**SEE Duration**	:	**3 hours**

Course Objective:
This course would facilitate understanding of the stages involved in automobile system design. The student will be exposed to industrial practices in design of various systems of an automobile.

Course Content: Chapters/ Units

1. **Body Shapes**: Aerodynamic Shapes, drag forces for small family cars.
   Fuel Injection: Spray formation, direct injection for single cylinder engines (both SI & CI), energy audit. **10 Hours**

2. **Design of I.C. Engine** I: Combustion fundamentals, combustion chamber design, cylinder head design for both SI & C. I. Engines. 10 **Hours**

3. **Design of I.C. Engine II**: Design of crankshaft, camshaft, connecting rod, piston & piston rings for small family cars (max up to 3cylinders). 10 **Hours**

4. **Transmission System**: Design of transmission systems – gearbox (max of 4-speeds), differential.
   Suspension System: Vibration fundamentals, vibration analysis (single & two degree of freedom, vibration due to engine unbalance, application to vehicle suspension. **10 Hours**

5. **Cooling System**: Heat exchangers, application to design of cooling system (water cooled).
   Emission Control: Common emission control systems, measurement of missions, exhaust gas emission testing. **12 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. **Design of Automotive Engines**, - A. Kolchin& V. Demidov, MIR Publishers, Moscow
2. **The motor vehicle, Newton steeds &Garratte -** Iliffee& sons Ltd., London
3. **I.C. Engines -** Edward F Obert, International text book company.

Reference Books:

1. **Introduction to combustion** - Turns
2. **Automobile Mechanic -**, N.K. Giri, Khanna Publications, 1994
3. **I.C. Engines** - Maleev, McGraw Hill book company, 1976
4. **Diesel engine design** – Heldt P.M., Chilton company New York.
5. **Problems on design of machine elements -** V.M. Faires & Wingreen, McMillan Company., 1965
6. **Design of I.C. Engines -** John Heywood, TMH

Course Outcome:

Upon completion of this course, the student will be able to

CO1	The student will be able to apply the knowledge in creating a preliminary design of automobile sub systems.
CO2	Students are exposed to aerodynamic analysis of the auto mobiles.
CO3	Students are exposed to engine performances, combustion analysis and exhaust gas analysis to meet the BIS standards (10000 series).

SYLLABUS COVERAGE FOR CIE-1, 2, 3
CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (First100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**
Unit	**1**		**2**		**3**		**4**		**5**	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

INDUSTRIAL VISIT

Course Code	**:**	**18MMDM16**		**CIE Marks**	**:**	**50**
Hrs./Week	**:**	**L: T: P: S 0:0:0:3**		**SEE Marks**	**:**	**50**
Credits	**:**	**02**		**SEE Duration**	**:**	**3 hours**

- **Industrial Visit**: At the end of second CIE the industrial visit will be arranged in the domain field, each student is required to submit the report of the visit.
- Report submissions and final Evaluation is to be carried out by the Internal Guide of the college and a senior faculty along with HOD.

II Semester

ADMISSION YEAR :2019-20 **ACADEMIC YEAR: 2019-20**

COURSE TITLE:	**ADVANCED MACHINE DESIGN**	
Sub Code: 18MMD21	**No of Credits: L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week: 04**
Exam Duration: 3 hours	**CIE Marks: 50**	**Exam Marks: 50**
Pre-requisites	**Engineering Mechanics, MoM, Design of Machine Elements**	

COURSE OBJECTIVES:

To study Role of failure prevention analysis in mechanical design. To acquaint with the concepts of damage fraction and accumulation in various damage theories. To study Role of surface failure in mechanical design. Enable the students to have high ethical standards in terms of team work to be a good design engineer.

#	CONTENTS	Hrs
UNIT-1	**INTRODUCTION:** Role of failure prevention analysis in mechanical design, Modes of mechanical failure, Review of failure theories for ductile and brittle materials including Mohr's theory and modified Mohr's theory, Numerical examples. **FATIGUE OF MATERIALS:** Introductory concepts, High cycle and low cycle fatigue, Fatigue design models, Fatigue design methods, Fatigue design criteria, Fatigue testing, Test methods and standard test specimens.	10
UNIT-2	**FATIGUE FROM VARIABLE AMPLITUDE LOADING:** Spectrum loads and cumulative damage, Damage quantification and the concepts of damage fraction and accumulation, Cumulative damage theories, Load interaction and sequence effects, Cycle counting methods, Life estimation using stress life approach.	10
UNIT-3	**SURFACE FAILURE:** Introduction, Surface geometry, Mating surface, Friction, Adhesive wear, Abrasive wear, Corrosion wear, Surface fatigue spherical contact, cylindrical contact, General contact, Dynamic contact stresses, Surface fatigue strength	10
UNIT-4	**STESS-LIFE (S-N) APPROACH:** S-N curves, Statistical nature of fatigue test data, General S-N behavior, Mean stress effects, Different factors influencing S-N behavior, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using S-N approach. **STRAIN-LIFE(E-N) APPROACH:** Monotonic stress-strain behavior, Strain controlled test methods, Cyclic stress-strain behavior, Strain based approach to life estimation, Determination of strain life fatigue properties, Mean stress effects, Effect of surface finish, Life estimation by ε-N approach.	12

UNIT-5	**LEFM APPROACH:** LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress effects, Crack growth life estimation. Notches and their effects: Concentrations and gradients in stress and strain, S-N approach for notched membranes, mean stress effects and Haigh diagrams, Notch strain analysis and the strain – life approach, Neuber's rule, Glinka's rule, applications of fracture mechanics to crack growth at notches.	10

Text Books:

1. **Ralph I. Stephens, Ali Fatemi, Robert, Henry o. Fuchs,** "Metal Fatigue in engineering", John Wiley New York, Second edition. 2001.
2. **Failure of Materials in Mechanical Design**, Jack. A. Collins, John Wiley, New York 1992.
3. **Robert L. Norton, "Machine Design",** Pearson Education India, 2000

Reference Books:

1. **S. Suresh, "Fatigue of Materials"**, Cambridge University Press, -1998
2. **Julie. A. Benantine,** "Fundamentals of Metal Fatigue Analysis", Prentice Hall,1990
3. **Fatigue and Fracture**, ASM Hand Book, Vol 19,2002.

SYLLABUS COVERAGE FOR CIE-1, 2, 3
CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (First100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**
Unit	**1**		**2**		**3**		**4**		**5**	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

<u>COURSE OUTCOMES:</u>

Learners will able to

CO1	Predict failure of engineering components using appropriate failure theories.

CO2	Identify and explain the types of fractures of engineered materials and their characteristic features;
CO3	Estimate life of components using stress life, strain life and LEFM approach.
CO4	Categorize different types of surface failures.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	3	2	2	3	2	3	1	3	3
CO2	2	3	3	2	3	3	3	1	2	3	3	2
CO3	3	3	2	3	3	3	1	3	3	2	3	2
CO4	3	3	2	3	3	2	3	2	1	2	3	3

ADVANCED THEORY OF VIBRATIONS

Course Code	**:**	**18MMD22**		**CIE Marks**	**:**	**50**
Hrs./Week	**:**	**L: T: P: 4:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 hours**

Course Objective:

To teach students how to use the theoretical principles of vibration, and vibration analysis techniques, for the practical solution of vibration problems. The course thus builds on student's prior knowledge of vibration theory, and concentrates on the applications. Thus, the student will fully understand the importance of vibrations in mechanical design of machine parts that operate in vibratory conditions.

Course Content: Chapters/ Units

1. **Review of Mechanical Vibrations:** Basic concepts; free vibration of single degree of freedom systems with and without damping, forced vibration of single DOF-systems, Natural frequency.
   Transient Vibration of single Degree-of freedom systems: Impulse excitation, Arbitrary excitation, Laplace transform formulation, pulse excitation and rise time, Shock response spectrum, Shock isolation. **10 Hours**

2. **Vibration Control:** Introduction, Vibration isolation theory, Vibration isolation and motion isolation for harmonic excitation, practical aspects of vibration analysis, shock isolation, Dynamic vibration absorbers, Vibration dampers.
   Vibration Measurement and applications: Introduction, Transducers, Vibration pickups, Frequency measuring instruments, Vibration exciters, Signal analysis. **10 Hours**

3. **Random Vibrations:** Random phenomena, Time averaging and expected value, Frequency response function, Probability distribution, Correlation, Power spectrum and power spectral density, Fourier transforms, FTs and response. **10 Hours**

4. **Modal analysis & Condition Monitoring:** Dynamic Testing of machines and Structures, Experimental Modal analysis, Machine Condition monitoring and diagnosis. Non-Linear Vibrations: Introduction, Sources of nonlinearity, Qualitative analysis of nonlinear systems. Phase plane, Conservative systems, Stability of equilibrium, Method of isoclines, Perturbation method, Method of iteration, Self-excited oscillations. **12 Hours**

5. **Continuous Systems:** Vibrating string, longitudinal vibration of rods, Torsional vibration of rods, Euler equation for beams.
   Different methods of vibration dissipation in structural components for general and rotating machinery. **110 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. Theory of Vibration with Application, - William T. Thomson, Marie Dillon Dahleh, Chandramouli Padmanabhan, 5th edition Pearson Education
2. S. Graham Kelly, “Fundamentals of Mechanical Vibration” - McGraw-Hill, 2000
3. S. S. Rao, “Mechanical Vibrations”, Pearson Education, 4^{th} edition.

Reference Books:

1. S. Graham Kelly, “Mechanical Vibrations”, Schaum’s Outlines, Tata McGraw Hill, 2007.
2. C Sujatha, “Vibrations and Acoustics – Measurement s and signal analysis Tata McGraw Hill, 2010

Course Outcome:

Upon completion of this course, the student will be able to

CO1	Model and analyze a free damped, undamped and forced response of a mechanical system.
CO2	Develop equation and analyze the transient response of a single degree freedom system.
CO3	Assess the response characteristics of a continuous mechanical system.
CO4	Analyze and discuss the behavior of single degree freedom system for linear and non-linear behavior.

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (First100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**
Unit	**1**		**2**		**3**		**4**		**5**	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	3	2	2	3	2	3	1	3	3
CO2	2	3	3	2	3	3	3	1	2	3	3	2
CO3	3	3	2	3	3	3	1	3	3	2	3	2
CO4	3	3	2	3	3	2	3	2	1	2	3	3

TRIBOLOGY AND BEARING DESIGN

Course Code	:	18MMD231		CIE Marks	:	50
Hrs/Week	:	L: T: P: 4:0:0		SEE Marks	:	50
Credits	:	04		SEE Duration	:	3 hours

Course Objective:

To educate students a clear understanding of factors to be considered in designing parts and components with focus on manufacturability.to study various regimes of lubrication. To acquaint with the concepts of pours and gas lubricated bearings. To study advanced bearing systems and their advantages over conventional bearing systems. Emphasis on various types of bearing systems.

1. **Introduction to Tribology:** Introduction, Friction, Wear, Wear Characterization, Regimes of lubrication, Classification of contacts, lubrication theories, Effect of pressure and temperature on viscosity. Newton's Law of viscous forces, Flow through stationary parallel plates. Hagen's Poiseuille's theory, viscometers. Numerical problems, Concept of lightly loaded bearings, Petroff's equation, Numerical problems. **10 Hours**

2. **Antifriction bearings:** Advantages, selection, nominal life, static and dynamic load bearing capacity, probability of survival, equivalent load, cubic mean load, bearing mountings.
   Porous Bearings: Introduction to porous and gas lubricated bearings. Governing differential equation for gas lubricated bearings, Equations for porous bearings and working principal, Fretting phenomenon and its stages. **10 Hours**

3. **Magnetic Bearings:** Introduction to magnetic bearings, Active magnetic bearings. Different equations used in magnetic bearings and working principal. Advantages and disadvantages of magnetic bearings, Electrical analogy, Magneto-hydrodynamic bearings.
   Advanced bearing systems and their advantages over conventional bearing systems, testing of different types of bearings **10 hours**

4. **Hydrodynamic Lubrications:** Pressure development mechanism. Converging and diverging films and pressure induced flow. Reynolds's 2D equation with assumptions. Introduction to idealized slide bearing with fixed shoe and Pivoted shoes. Expression for load carrying capacity. Location of center of pressure, effect of end leakage on performance, Numerical problems
   Journal Bearings: Introduction to idealized full journal bearings. Load carrying capacity of idealized full journal bearings, Sommer Feld number and its significance, short and partial bearings, Comparison between lightly loaded and heavily loaded bearings, effects of end leakage on performance, Numerical problems. **12 Hours**

5. **Hydrostatic Bearings:** Hydrostatic thrust bearings, hydrostatic circular pad, annular pad, rectangular pad bearings, types of flow restrictors, expression for discharge, load carrying capacity and condition for minimum power loss, numerical problems, and hydrostatic journal bearings.
   EHL Contacts: Introduction to Elasto- hydrodynamic lubricated bearings. Introduction to 'EHL' constant, Grubin type solution. **10 Hours**

NOTE: Students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books

1. Mujamdar.B.C "Introduction to Tribology of Bearing", Wheeler Publishing, New Delhi 2001
2. Radzimovsky, "Lubrication of Bearings - Theoretical principles and design" Oxford press Company, 2000

Reference Books

1. Dudley D. Fulier " Theory and practice of Lubrication for Engineers", New YorkCompany.1998
2. Moore "Principles and applications of Tribology" Pergamon press, 1975
3. Oscar Pinkus, Beno Sternlicht, "Theory of hydro dynamic lubrication", McGraw-Hill, 1961
4. G W Stachowiak, A W Batchelor, "Engineering Tribology", Elsevier publication 1993.
5. Hydrostatic and hybrid bearings, Butterworth 1983.
6. F. M. Stansfield, Hydrostatic bearings for machine tools and similar applications, Machinery Publishing, 1970

Course Outcome:

Upon completion of this course, the student will be able to

CO1	Students develop skills to design and selection of bearings on Various tribological factors to be considered in moving and rotating parts.
CO2	The students are exposed to orient towards the various types of bearings and their applications.
CO3	Students are exposed to synthesis and analysis of the bearings including fault diagnosis.

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (First100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Unit	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.

3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	3	2	2	3	2	3	1	3	3
CO2	2	3	3	2	3	3	3	1	2	3	3	2
CO3	3	3	2	3	3	3	1	3	3	2	3	2
CO4	3	3	2	3	3	2	3	2	1	2	3	3

ADMISSION YEAR:2019-20 **ACADEMIC YEAR: 2019-20**

COURSE TITLE: DESIGN OPTIMIZATION		
Sub Code:18MMD232	**No of Credits: L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week: 04**
Exam Duration: 3 hours	**CIE Marks: 50**	**Exam Marks: 50**
Pre-requisites	**Research methodology, Composite material, Basic mathematics**	

COURSE OBJECTIVES:

It aids the students to acquire the basics of optimum design, Classical Optimization Techniques, Non - linear Programming, Unconstrained Optimization Techniques, Integer Programming and Dynamic Programming.To study the basics of Design optimization. To acquaint Optimum Design Problem Formulation. To study the Sensitivity Analysis, Linear and Non-Linear Approximations and Optimization Disciplines.To gain knowledge of different Manufacturability in Optimization Problems and Design Interpretation.

#	CONTENTS	Hrs
UNIT-1	**Engineering Design Practice:** Evolution of Design Technology, Introduction to Design and the Design Process, Design versus Analysis, Role of Computers in Design Cycle, Impact of CAE on Design, Numerical Modeling with FEA and Correlation with Physical Tests.	10
UNIT-2	**Optimum Design Problem Formulation**: Types of Optimization Problems, The Mathematics of Optimization, Design Variables and Design Constraints, Feasible and Infeasible Designs, Equality and Inequality Constraints, Discrete and Continuous Optimization, Linear and Non-Linear Optimization. **Optimization Theory** – Fundamental Concepts, Global and Local Minimum, Gradient Vector and Hessian Matrix, Concept of Necessary and Sufficient Conditions, Constrained and Unconstrained Problems, Lagrange Multipliers and Kuhn Tucker Conditions	10
UNIT-3	**Sensitivity Analysis, Linear and Non-Linear Approximations**. Gradient Based Optimization Methods – Dual and Direct. **Optimization Disciplines:** Conceptual Design Optimization and Design Fine Tuning, Combined Optimization, Optimization of Multiple Static and Dynamic Loads, Transient Simulations, Equivalent Static Load Methods	10
UNIT-4	**Manufacturability in Optimization Problems:** Design for Manufacturing, Manufacturing Methods and Rules, Applying Manufacturing Constraints to Optimization Problems. **Design Interpretation:** Unbound Problems, Over Constrained Problems, Problems with No of Multiple Solutions, Active and Inactive Constraints, Constraint Violations and Constraint Screening, Design Move Limits, Local and Global Optimum	12

UNIT-5	**Dynamic Programming:** Introduction, Multistage decision processes, Principle of optimality, Computational Procedure in dynamic programming, Initial value problem, Examples. **Applications of Optimization in Engineering Design:** Automotive, Aerospace and General Industry Applications, Optimization of Metallic and Composite Structures, Minimization and Maximization Problems, MDO and MOO	10

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. S.S. Rao, Engineering Optimization: Theory and Practice, John Wiley, 2009
2. JasbirArora, Introduction to Optimum Design, McGraw Hill, 2011.

Reference Books:

1. Optimization and Probability in System Engg - Ram, Van Nostrand.
2. Optimization methods - K. V. Mital and C. Mohan, New age International Publishers, 1999.
3. Optimization methods for Engg. Design - R.L Fox, Addison – Wesley, 1971.

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (First100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Unit	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

Course Outcome:

At the completion of this course, students will be able to:

CO1	It provides the student with knowledge required to optimize an existing design with single or multiple objective functions.
CO2	Skills acquired through commercial optimization programs
CO3	Acquire the knowledge of engineering system design

MAPPING OF COs WITH Pos

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	3	2	2	3	2	3	1	3	3
CO2	2	3	3	2	3	3	3	1	2	3	3	2
CO3	3	3	2	3	3	3	1	3	3	2	3	2
CO4	3	3	2	3	3	2	3	2	1	2	3	3

ADMISSION YEAR : 2019-20 ACADEMIC YEAR: 2019-20

COURSE TITLE: COMPOSITE MATERIALS TECHNOLOGY		
Sub Code:18MMD241	**No of Credits: L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week: 04**
Exam Duration: 3 hours	**CIE Marks: 50**	**Exam Marks: 50**
Pre-requisites	MECHATRONICS, COMPOSITE MATERIALS, SMART MATERIALS	

COURSE OBJECTIVES:

To study the basics of Composite materials. To acquaint mechanics of lamina. To study the micro and macro analysis of the lamina. To gain knowledge of different techniques involved in production of composites.

#	CONTENTS	Hrs
UNIT-1	**Introduction to Composite Materials:** Definition, Classification, Types of matrices material and reinforcements, Characteristics &selection, Fiber composites, laminated composites, Particulate composites, Prepegs, and sandwich construction. **Metal Matrix Composites:** Reinforcement materials, Types, Characteristics and selection, Base metals, Selection, Applications	10
UNIT-2	**Macro Mechanics of a Lamina:** Hooke's law for different types of materials, Number of elastic constants, Derivation of nine independent constants for orthotropic material, Two - dimensional relationship of compliance and stiffness matrix. Hooke's law for two-dimensional angle lamina, engineering constants - Numerical problems. Invariant properties. Stress-Strain relations for lamina of arbitrary orientation, Numerical problems.	10
UNIT-3	**Micro Mechanical Analysis of a Lamina:** Introduction, Evaluation of the four elastic moduli, Rule of mixture, Numerical problems. Experimental Characterization of Lamina- Elastic Moduli and Strengths **Failure Criteria:** Failure criteria for an elementary composite layer or Ply, Maximum Stress and Strain Criteria, Approximate strength criteria, Inter-laminar Strength, Tsa-Hill theory, Tsai, Wu tensor theory, Numerical problem, practical recommendations	10
UNIT-4	**Macro Mechanical Analysis of Laminate**: Introduction, code, Kirchoff hypothesis, Classical Lamination Theory, A, B, and D matrices (Detailed derivation), Special cases of laminates, Numerical problems. Shear Deformation Theory, A, B, D and E matrices (Detailed derivation) **Analysis of Composite Structures:** Optimization of Laminates, composite laminates of uniform strength, application of optimal composite structures, composite pressure vessels, spinning composite disks, composite lattice structures	12
UNIT-5	**Manufacturing and Testing:** Layup and curing - open and closed Mould processing, Hand lay-up techniques, Bag moulding and filament winding. Pultrusion, Pulforming, Thermoforming, Injection moulding, Cutting, Machining, joining and repair. NDT tests – Purpose, Types of defects, NDT method - Ultrasonic inspection, Radiography, Acoustic emission and Acoustic ultrasonic method.	10

	Applications: Aircrafts, missiles, Space hardware, automobile, Electrical and Electronics, Marine, Recreational and sports equipment-future potential of composites. .	

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. Autar K. Kaw, Mechanics of Composite materials, CRC Press, 2nd Ed, 2005.
2. Madhijit Mukhopadhay, Mechanics of Composite Materials & Structures, Universities Press, 2004.

Reference Books:

1. J. N. Reddy, Mechanics of Laminated Composite Plates & Shells, CRD Press, 2nd Ed, 2004.
2. Mein Schwartz, Composite Materials handbook, McGraw Hill, 1984.
3. Rober M. Jones, Mechanics of Composite Materials, Taylor & Francis, 1998.
4. Michael W, Hyer, Stress analysis of fiber Reinforced Composite Materials, Mc-Graw Hill International, 2009.
5. Composite Material Science and Engineering, Krishan K. Chawla, Springer, 3e, 2012.
6. Fiber Reinforced Composites, P.C. Mallik, Marcel Decker, 1993.

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (First100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Unit	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

Course Outcome:

At the completion of this course, students will be able to:

CO1	Identify the role of matrices and reinforcements used in practical composite structures.
CO2	Analyze problems on micro and macro mechanical behavior of lamina.
CO3	Assess the strength of laminated composite and predict its failure for given static loading conditions.
CO4	Develop understanding of different methods of manufacturing and testing of composites.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	3	2	2	3	2	3	1	3	3
CO2	2	3	3	2	3	3	3	1	2	3	3	2
CO3	3	3	2	3	3	3	1	3	3	2	3	2
CO4	3	3	2	3	3	2	3	2	1	2	3	3

ADMISSION YEAR : 2019-20 ACADEMIC YEAR: 2019-20

<table>
<tr><td colspan="3">COURSE TITLE: FINITE ELEMENT METHODS FOR HEAT TRANSFER AND FLUID FLOW ANALYSIS</td></tr>
<tr><td>Sub Code: 18MMD242</td><td>No of Credits: L-T-P-SS
4:0:0:0 =4</td><td>No. of lecture hours/week: 04</td></tr>
<tr><td>Exam Duration: 3 hours</td><td>CIE Marks: 50</td><td>Exam Marks: 50</td></tr>
<tr><td>Pre-requisites</td><td colspan="2">FINITE ELEMENT METHODS, BASIC THERMODYNAMICS, HEAT AND MASS TRANSFERR</td></tr>
</table>

COURSE OBJECTIVES:

To study the basic sources of Heat transfer and fluid mechanics. To acquaint with the effects of steady state conduction heat transfer. To study the advance topic in conduction. To gain knowledge of Flows of Viscous Incompressible Fluids.

#	CONTENTS	Hrs
UNIT-1	**Introduction to Heat Transfer and Fluid Mechanics:** Mathematical Preliminaries, Governing equations of a continuum, Governing equation in terms of primitive variables, porous equations, low speed compressible flow equations, auxiliary transport equations, chemically reacting systems, boundary conditions, change of phase, enclosure radiation. **Finite Element Methods:** Introduction, model differential equation, finite element approximations, interpolation functions, library of finite elements, modeling considerations, assembly of elements, numerical integration, discussion of results with some practical examples, time dependent problems.	10
UNIT-2	**Steady State Conduction Heat Transfer:** Introduction, one dimensional linear, quadratic element. Homogeneous, composite wall with uniform and varying cross-sectional area. Radial heat flow in a cylinder. Conduction –convection systems. Numerical examples. **Conduction Heat Transfer:** Interpolation functions for tetrahedral, hexahedral, pyramid and prism elements. Numerical integration, computation of surface flux, semi-discrete finite element model,	10
UNIT-3	**Advanced topic in Conduction:** specialty elements, computation of boundary conditions, bulk nodes, reactive materials, material motions Example problems on conduction, radiation, temperature dependent conductivity, anisotropic conduction, brazing and welding, investment casting.	10
UNIT-4	**Flows of Viscous Incompressible Fluids:** Governing equation mixed finite element model, penalty finite element models. Finite element models of porous flow, solution of nonlinear equations for transient problems. Radiation algorithms. Variable properties. **Computational consideration:** Interpolation functions for triangular, quadrilateral, tetrahedral and hexahedral elements. Evaluation of element matrices in penalty model, pressure calculation and traction boundary conditions. Numerical examples	12
UNIT-5	**Coupled Fluid Flow and Heat Transfer:** Introduction to non-isothermal incompressible flows, governing equations and boundary condition. Mixed, penalty finite element model. Finite element model for porous flow. Non-isothermal low speed compressible flows: governing equation, boundary conditions, mixed finite element model and solution methods. Convection with change of phase, convection with enclosure radiation, turbulent heat transfer, chemically reacting systems. Numerical examples.	10

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

Text Books:

1. J N Reddy, David K. Gartling, "The finite element method in heat transfer and flu id dynamics" , CRC, 2004.
2. Roland Wynne Lewis, Perumal Nithiarasu, K. N. Seetharamu," Fundamentals of the finite element method for heat and fluid flow"
   John Wiley, 2004

Reference Books:

1. Ching Jen Chen, R. A. Bernatz, "Finite analytic method in flows and heat transfer", Taylor & Francis.
2. Gianni Comini, Stefano Del Giudice, Carlo Nonino, "Finite Element Analysis in Heat Transfer: Basic Formulation and Linear problems" Taylorand Francis, 1994.

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (First100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Unit	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

Course Outcome:

Upon completion of this course, the student will be able to

CO1	This course enables the student to use numerical methods for solving problems of fluid flow and heat transfer.
CO2	Analyze of the continuum mechanics problems like fluid flow, heat transfer.
CO3	Analyze of incompressible and compressible fluids.
CO4	Analyze modes of conduction in various mechanical systems

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	3	2	2	3	2	3	1	3	3
CO2	2	3	3	2	3	3	3	1	2	3	3	2
CO3	3	3	2	3	3	3	1	3	3	2	3	2
CO4	3	3	2	3	3	2	3	2	1	2	3	3

ADMISSION YEAR:2019-20 **ACADEMIC YEAR: 2019-20**

COURSE TITLE: THEORY OF PLASTICITY		
Sub Code: MMD251	**No of Credits: L-T-P-SS 4:0:0:0 =4**	**No. of lecture hours/week: 04**
Exam Duration: 3 hours	**CIE Marks: 50**	**Exam Marks: 50**
Pre-requisites	**DESIGN OF MACHINE ELEMENTS, ADVANCED MECHANICS OF SOLIDS.**	

COURSE OBJECTIVES:

To study the basic concept of stresses, stress distribution, elastic constants when the material is subjected to loading within the elastic limits. Study the stress distribution in plane, polar and cylindrical coordinate systems. Analyze the material or component subjected to torsion of circular and non-circular shafts (elliptical, triangular bars) Study the thermo-elastic properties of the material at elevated temperatures.

#	CONTENTS	Hrs
UNIT-1	**DEFINITION AND SCOPE OF THE SUBJECT:** Brief review of elasticity, Octahedral normal and shear stresses, Spherical and deviatoric stress, Invariance in terms of the deviatoric stresses, Engineering and natural strains, Mathematical relationships between true stress and true strains, Cubical dilation, finite strains co- efficient Octahedral strain, Strain rate and the strain rate tensor.	10
UNIT-2	**PLASTIC STRESS-STRAIN RELATIONS:** Prandtl-Reuss Saint Venant, Levy-Mises, Experimental verification of the Prandtl-Reuss equation, Upper and lower bound theorems. Application to problems: Uniaxial tension and compression.	10
UNIT-3	**SLIP LINE THEORY**: Introduction, Basic equations for incompressible two-dimensional flow, continuity equations, Stresses in conditions of plain strain convention for slip-lines, Geometry of slip lines, Properties of slip lines.	10
UNIT-4	**MATERIAL MODELS:** Stress-strain relations, Yield criteria for ductile metal, Von Mises, Tresca, Yield surface for an Isotropic Plastic material, Stress space, Experimental verification of Yield criteria, Yield criteria for an anisotropic material, flow rule normality of Yield locus, Symmetry and convexity, Deformation of isotropic and kinematic hardening, bilinear stress-strain relationship.	12
UNIT-5	**BENDING OF BEAMS:** Torsion of rods and tubes, Nonlinear bending and torsion equations, Simple forms of indentation problems using upper bounds, Application of Metal forming: Extrusion, Drawing, Rolling and Forging.	**10**

TEXT BOOKS

1. **R. A. C. Slater**, "Engineering Plasticity - Theory and Application to Metal Forming Process", McMillan Press Ltd., 1977.

2. **SADHU SINGH, "Theory of Plasticity and Metal forming Process", Khanna Publishers, Delhi, 1999.**

REFERENCE BOOKS

1. HOFFMAN AND SACHS, "Introduction to the Theory of Plasticity for Engineers", LLC, 2012.
2. **J CHAKRABARTY**, "Theory of plasticity", Butterworth, 2006. 3. Johnson and Mellor, "Plasticity for Mechanical Engineers", Van Nostrand, 1966.
3. **PLASTICITY FOR MECHANICAL ENGINEERS** - Johnson and Mellor, Van Nostrand, 1966.

SYLLABUS COVERAGE FOR CIE-1, 2, 3
CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (First100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**
Unit	**1**		**2**		**3**		**4**		**5**	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO1	Apply basic concepts in continuum mechanics of solids viz. Stress and strain tensors, equilibrium, compatibility and constitutive equations and methods of solution to elasticity problems
CO 2	Evaluate stresses and displacements in simple solids such as pressurized cylinders, shrink fitted cylinders, rotating disc and shaft, plate with hole and non-circular shafts and thin tubes under torsion.
CO 3	Use MATLAB or equivalent software to evaluate and plot particular solutions.
CO 4	Apply the principles of plastic deformation to estimate yielding in simple engineering structures.
CO 5	Apply principles of continuum mechanics to design a structure or component to achieve desired performance under realistic constraints.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	3	2	2	3	3	2	3	3	1	2
CO2	2	3	3	2	2	1	3	2	3	3	3	2
CO3	3	3	3	2	3	2	3	1	3	2	3	2
CO4	3	3	2	2	3	2	3	1	2	2	3	3

ROTOR DYNAMICS

Course Code	:	18MMD252		CIE Marks	:	50
Hrs/Week	:	L: T: P: 4:0:0		SEE Marks	:	50
Credits	:	04		SEE Duration	:	3 hours

Course Objective:
To make student to understand the concept of turbo machinery. To enable them to design specifically modeling of bearings, shafts and rotor stages. To guide them to predict instability like whirling including gyroscopic and Coriolis effect. To find the methods of reducing blade vibrations

1. **Fluid Film Lubrication:** Basic theory of fluid film lubrication, Derivation of generalized Reynolds equations, Boundary conditions, Fluid film stiffness and Damping coefficients, Stability and dynamic response for hydrodynamic journal bearing, Two lobe journal bearings.
10 Hours

2. **Critical Speed:** Dunkerley's method, Rayleigh's method, Stodola's method. Rotor Bearing System: Instability of rotors due to the effect of hydrodynamic oil layer in the bearings, support flexibility, Simple model with one concentrated mass at the center.
Introduction to Jeffcott rotor. Concepts, mathematical equations, applications. **10 Hours**

3. **Turbo rotor System Stability by Transfer Matrix Formulation:** General Turborotor system, development of element transfer matrices, the matrix differential equation, effect of shear and rotary inertia, the elastic rotors supported in bearings, numerical solutions. **10 Hours**

4. **Turbo rotor System Stability by Finite Element Formulation:** General Turborotor system, generalized forces and co-ordinates system assembly element matrices, Consistent mass matrix formulation, Lumped mass model, linearized model for journal bearings, System dynamic equations Fix stability analysis non dimensional stability analysis, unbalance response and Transient analysis. **12 Hours**

5. **Blade Vibration:** Centrifugal effect, Transfer matrix and Finite element, approaches. **10 Hours**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry.

Reference Books:

1. Cameron, “Principles of Lubrication”, Longman Publishing Group, 1986
2. Bolotin, “Nonconservative problems of the Theory of elastic stability”, Macmillan, 1963
3. Peztel, Lockie, “Matrix Methods in Elasto Mechanic s”, McGraw-Hill, 1963.
4. Timoshenko, “Vibration Problems in Engineering”, Ox ford City Press, 2011
5. Zienkiewicz, “The finite element method in engineering science”, McGraw-Hill, 1971

Course Outcomes:

Upon completion of this course, the student will be able to

CO1	Model a rotating machine element theoretically for rotor dynamic analysis.
CO2	Analyze Free and Forced lateral response of simple rotor models and of more complex systems including shafts, bearings, seals and stators.
CO3	Formulate Finite element and carry out analysis for Turborotor System Stability.
CO4	Apply Finite element approach to blade vibration.

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)
CIE-2: UNIT-2 (50%) + UNIT -3 (First100%)
CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**
Unit	**1**		**2**		**3**		**4**		**5**	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

MAPPING OF COs WITH POs

COs/POs	**po1**	**po2**	**po3**	**po4**	**po5**	**po6**	**po7**	**po8**	**po9**	**po10**	**po11**	**po12**
CO1	3	3	3	2	2	3	3	2	3	3	1	2
CO2	2	3	3	2	2	1	3	2	3	3	3	2
CO3	3	3	3	2	3	2	3	1	3	2	3	2
CO4	3	3	2	2	3	2	3	1	2	2	3	3

RESEARCH METHODOLOGY

Course Code	**:**	**18RM27**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L: T: P: 2:0:0**		**SEE Marks**	**:**	**50**
Credits	**:**	**02**		**SEE Duration**	**:**	**3 hours**

Course Learning Objectives: Students are expected to

- Have a basic understanding of the underlying principles of quantitative and qualitative research
- Identify the overall process of designing a research study from its inception to its report.
- Choose the most appropriate research method to address a particular research question
- Gain a overview of a range of quantitative and qualitative approaches to data analysis

1. **Overview of Research:** Research and its types, identifying and defining research problem and introduction to different research designs. Essential constituents of Literature Review. Basic principles of experimental design, Primary data and Secondary Data, methods of primary data collection, classification of secondary data, designing questionnaires and schedules. **8 Hours**

2. **Sampling Methods:** Probability sampling: simple random sampling, systematic sampling, stratified sampling, cluster sampling and multistage sampling. Non-probability sampling: convenience sampling, judgment sampling, quota sampling. Sampling distributions. **6 Hours**

3. **Processing and analysis of Data:** Statistical measures and their significance: Central tendencies, variation, skewness, Kurtosis, time series analysis, correlation and regression, Testing of Hypotheses: Parametric (t and Chi Square). **6 Hours**

4. **Essential of Report writing and Ethical issues**: Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Ethical issues related to Research, Plagiarism and self- Plagiarism, Publishing. **6 Hours**

Reference Books:

1. Krishnaswami, K.N., Sivakumar, A. I. and Mathirajan, M., Management Research Methodology, Pearson Education: New Delhi.
2. Kothari C.R., Research Methodology Methods and techniques by, New Age International Publishers, 2nd edition
3. Levin, R.I. and Rubin, D.S., Statistics for Management, 7th Edition, Pearson Education: New Delhi.

Course Outcome:

At the end of the course students will:

CO1	Describe a range of quantitative and qualitative research designs and identify the advantages and disadvantages associated with these designs
CO2	Choose appropriate quantitative or qualitative method to collect data
CO3	Analyse and test the given data using appropriate methods
CO4	Design an appropriate mixed-method research study to answer a research question

SEMESETER III

ADMISSION YEAR:2019-20 **ACADEMIC YEAR: 2019-20**

COURSE TITLE: FRACTURE MECHANICS		
Sub Code: 18MMD31	**No of Credits: L-T-P-SS** **4:0:0:0=4**	**No. of lecture hours/week :04**
Exam Duration :3 hours	**CIE Marks:50**	**Exam Marks :50**
Pre-requisites	**Metrology & Measurements, Design of Machine Elements'**	

COURSE OBJECTIVES:

Fracture mechanics provides a methodology for prediction, prevention and control of fracture in materials, components and structures. It provides a background for damage tolerant design. It quantifies toughness as materials resistance to crack propagation.

#	CONTENTS	Hrss
UNIT-1	**FRACTURE MECHANICS PRINCIPLES:** Introduction and historical review, Sources of micro and macro cracks. Stress concentration due to elliptical hole, Strength ideal materials, Griffith's energy balance approach. Fracture mechanics approach to design. NDT and Various NDT methods used in fracture mechanics. The Airy stress functions. Complex stress function. Effect of finite size. Special cases, Elliptical cracks.	10
UNIT-2	**PLASTICITY EFFECTS:** Irwin plastic zone correction. Dugdale approach. The shape of the plastic zone for plane stress and plane strain cases, Plastic constraint factor. The Thickness effect, numerical problems. **Determination of Stress intensity factors and plane strain fracture toughness**: Introduction, analysis and numerical methods, experimental methods, estimation of stress intensity factors. Plane strain fracture toughness test, The Standard test.	10
UNIT-3	**THE ENERGY RELEASE RATE:** Criteria for crack growth. The crack resistance (R curve). Compliance, J integral. Tearing modulus. Stability.	10

UNIT-4	**ELASTIC PLASTIC FRACTURE MECHANICS:** Fracture beyond general yield. The Crack-tip opening displacement. The Use of CTOD criteria. Experimental determination of CTOD. Parameters affecting the critical CTOD. Use of J integral. Limitation of J integral. **DYNAMICS AND CRACK ARREST:** Crack speed and kinetic energy. Dynamic stress intensity and elastic energy release rate. Crack branching. Principles of crack arrest. Crack arrest in practice. Dynamic fracture toughness**.**	12
UNIT-5	**FATIGUE CRACK PROPAGATION AND APPLICATIONS OF FRACTURE MECHANICS:** Crack growth and the stress intensity factor. Factors affecting crack propagation. variable amplitude service loading, means to provide fail-safety, required information for fracture mechanics approach, Mixed mode (combined) loading and design criteria.	10

Text Books:

1. **David Broek,** "Elementary Engineering Fracture Mechanics", Springer Netherlands,2011
2. **Anderson**, "Fracture Mechanics-Fundamental and Application", T.L CRC press1998.

Reference Books:

1. **Karen Hellan**, "Introduction to fracture mechanics", McGraw Hill, 2nd Edition
2. **S.A. Meguid**, "Engineering fracture mechanics" Elsevier Applied Science, 1989
3. **Jayatilaka,** "Fracture of Engineering Brittle Materials", Applied Science Publishers, 1979
4. **Rolfe and Barsom**, "Fracture and Fatigue Control in Structures", Prentice Hall, 1977
5. **Knott**, "Fundamentals of fracture mechanisms", Butterworths, 1973

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (50%)

CIE-2: UNIT-2 (50%) + UNIT -3 (Firs100%)

CIE-3: UNIT- 4 (100%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	

(Irrespective of portions covered due to whatever might be the reason)

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

COURSE OUTCOMES:

Learners will able to

CO1	Develop fundamental understanding of the effects of crack like defects on the performance of aerospace, civil, and mechanical engineering structures.
CO2	Select appropriate materials for engineering structures to ensure damage tolerance.
CO3	Employ modern numerical methods to determine critical crack sizes and fatigue crack propagation rates in engineering structures.
CO4	Gain appreciation of the status of academic research in field of fracture mechanics.

MAPPING OF COs WITH Pos

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	-	-	-	-	3	2	-	1	-	-
CO2	2	3	-	2	-	-	-	-	-	3	-	-
CO3	3	3	-	-	-	3	-	-	-	-	--	-
CO4	3	3	2	-	-	1	-	-	-	-	-	-

ADMISSION YEAR:2019-20 **ACADEMIC YEAR: 2019-2020**

COURSE TITLE: SMART MATERIALS AND STRUCTURES		
Sub Code: 18MMD321	**No of Credits: L-T-P-S** **4:0:0:0 =4**	**No. of lecture hours/week :04**
Exam Duration: 3 hours	**CIE Marks: 50**	**Exam Marks:50**
Pre-requisites	Mechatronics, Composite materials technology**.**	

COURSE OBJECTIVES:

To study the basic sources of smart materials and structures. To acquaint with the effects of Shape memory Alloy, ER and MR fluids. To study the usefulness of vibration absorbers and control of structures. To gain knowledge of MEMS and devices.

#	CONTENTS	Hrss
UNIT-1	**Smart Structures**: Types of Smart Structures, Potential Feasibility of Smart Structures, Key Elements of Smart Structures, Applications of Smart Structures. Piezoelectric materials, Properties, piezoelectric Constitutive Relations, Depoling and Coersive Field, field strain relation. Hysteresis, Creep and Strain Rate effects, Inchworm Linear Motor.	10
UNIT-2	**Beam Modeling:** Beam Modeling with induced strain Rate effects, Inchworm Linear Motor Beam Modeling with induced strain Actuation-single Actuators, dual Actuators, Pure Extension, Pure Bending harmonic excitation, Bernoulli-Euler beam Model, problems, Piezoelectric Applications.	10
UNIT-3	**Shape memory Alloy:** Experimental Phenomenology, Shape Memory Effect, Phase Transformation, Tanaka's Constitutive Model, testing of SMA Wires, Vibration Control through SMA, Multiplexing. Applications Of SMA and Problems. **ER and MR Fluids:** Mechanisms and properties, Fluid Composition and behavior, The Bingham Plastic and Related Models, Pre-Yield Response. Post-Yield flow applications in Clutches, Dampers and Others	12
UNIT-4	**Vibration Absorbers:** series and Parallel Damped Vibrations (Overview), Active Vibration Absorbers, Fiber Optics, Physical Phenomena, Characteristics, Sensors, Fiber Optics in Crack Detection, applications. **Control of Structures:** Modeling, Control Strategies and Limitations, Active Structures in Practice.	10
UNIT-5	**MEMS** – Mechanical Properties of MEMS Materials, Scaling of Mechanical Systems, Fundamentals of Theory, The Intrinsic Characteristics of MEMS, Miniaturization, Microelectronics Integration.	10

	Devices: Sensors and Actuators, Conductivity of Semiconductors, Crystal Planes and Orientation, (Stress and Strain Relations, Flexural Beam Bending Analysis Under Simple Loading Conditions), Polymers in MEMS, Optical MEMS Applications.	

Text Books:

1. Smart Materials and Structures -**M. V. Gandhi and B.S Thompson**, Chapman and Hall, London; New York, 1992 (ISBN: 0412370107).
2. Smart Structures and Materials **- Culshaw, Artech House, Boston**, 1996 (ISBN :0890066817).
3. Smart Structures: Analysis & Design **- A. Srinivasan**, Cambridge University Press, Cambridge; New York, 2001 (ISBN: 0521650267).

Reference Books:

1. Electro ceramics: Materials, Properties and Applications - **A. J. Moulson and J. M. Herbert**. John Wiley & Sons, ISBN: 0471497429
2. **Piezoelectric Sensories**: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors. Materials and Amplifiers, Springer, Berlin; New York, 2002 (ISBN: 3540422595).
3. Piezoelectric Actuators and Wtrasonic Motors -**K. Uchino, Kluwer** Academic Publishers, Boston, 1997 (ISBN: 0792398114).
4. Handbook of Giant Magneto strictive Materials - **G. Engdahl**, Academic Press, San Diego, Calif.; London, 2000 (ISBN: 012238640X).
5. Shape Memory Materials **- K. Otsuka and C.M. Wayman**, Cambridge University Press, Cambridge; New York, 199~ (ISBN: 052144487X).

SYLLABUS COVERAGE FOR CIE-1, 2, 3

CIE-1: UNIT-1 (100%) + UNIT- 2 (100%)

CIE-2: UNIT-3 (100%) + UNIT -4 (50%)

CIE-3: UNIT- 4 (50%) + UNIT- 5 (100%)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	

(Irrespective of portions covered due to whatever might be the reason)

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

Course Outcome:

At the completion of this course, students will be able to:

CO1	Understand the behavior and applicability of various smart materials.
CO2	Design Simple models for smart structures and materials
CO3	Perform simulation of smart structures and material application.
CO4	Conduct experiments to verify the predictions.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	3	3	--	-	2	-	-	-	-	-	-	-
CO2	2	3	-	2	-	-	-	1	-	-	3	-
CO3	3	-	2	-	3	-	1	-	-	2	-	2
CO4	3	-	2	-	-	-	-	-	-	-	-	-

ADMISSION YEAR: 2019-20 **ACADEMIC YEAR: 2019-20**

COURSE TITLE: STATISTICAL MODELING AND EXPERIMENTAL DESIGN		
Sub Code: 18MMD322	**No of Credits: L-T-P-SS** **4:0:0:0=4**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**
Pre-requisites	Mom, Experimental Mechanics, Finite Element Method.	

COURSE OBJECTIVES:

The objective of this course is to impart students with a holistic view of the fundamentals of experimental designs, analysis tools and techniques, interpretation and applications.

	CONTENTS	**Hrss**
UNIT-1	**Statistical Modeling and Data Analysis:** Introduction, Review of basic statistical concepts: Concepts of random variable, Sample and population, Measure of Central tendency; Mean, median and mode. Illustration through Numerical examples, Normal, Log Normal & Weibull distributions. Illustration through Numerical examples.	10
UNIT-2	**Introduction to Designed Experiments:** Strategy of experimentation, some typical applications of experimental design, Basic principles, Guidelines for designing experiments, A brief history of statistical design, Summary: Using statistical techniques in experimentation.	10
UNIT-3	**Factorial Experiments** Basic definitions, The advantages of factorials, The two-factorial design. Introduction, Factorial Experiments Terminology: factors, levels, interactions, Two-level experimental designs for two factors and three factors. Illustration through Numerical examples.	12
UNIT-4	**Regression Analysis:** linear and multiple Regression analysis, Mathematical models from experimental data. Illustration through Numerical examples.	10
UNIT-5	**Signal to Noise Ratio:** Evaluation of sensitivity to noise. Signal to Noise ratios for static problems: Smaller-the-batter type, Nominal the-better-type, Larger-the better type. Signal to Noise for Dynamic problems. Illustration through Numerical examples.	**10**

TEXT BOOKS:

1. **Design and Analysis of Experiments,** Douglas C. Montgomery, 5th Edition Wiley India Pvt. Ltd. 2007.
2. **Quality engineering using robust design**, Madhav s. Phadke, Prentice Hall PTR, Englewood Cliffs, NewJersy 07632, 1989.

REFERENCES BOOKS:

1. Thomas B. Barker, **"Quality if experimental design",** Marcel Dekker Inc ASQC Quality Press.1985.
2. C.F. Jeff Wu Michael Hamada, **"Experiments Planning Analysis and Parameter Design Optimization",** Wiley Editions. 2002.
3. L. W. Condra**, "Reliability Improvement with design of Experiments",** 2nd ed, CRC Press, 2001
4. Phillip j. Ross, **"Taguchi Techniques for Quality Engineering",** 2nd ed. McGraw Hill International Editions, 1996.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)

CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

(Irrespective of portions covered due to whatever might be the reason)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO1	Basic statistics including ANOVA and regression.
CO2	Experimental designs such as RCBD, BIBD, Latin Square, factorial and fractional factorial designs.
CO3	Application of statistical models in analyzing experimental data.
CO4	RSM to optimize response of interest from an experiment.
CO5	Robust design of process and product.

MAPPING OF COs WITH POs

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	1	1	-	2	-	-	-	-	-	-	-	-
CO2	2	-	3	2	-	-	-	--	-	-	-	-
CO3	3	3	-	2	3	2	3	-	-	-	-	-
CO4	3	-	2	-	-	-	-	-	2	-	-	-

ADMISSION YEAR: 2019-20 **ACADEMIC YEAR: 2019-20**

COURSE TITLE: OPTIMIZATION TECHNIQUES		
Sub Code: 18MMD323	**No of Credits: L-T-P-SS** **4:0:0:0=4**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**
Pre-requisites	Mom, Experimental Mechanics, Finite Element Method.	

COURSE OBJECTIVES:

To understand the theory of optimization methods and algorithms developed for solving various types of optimization problems. To develop and promote research interest in applying optimization techniques in problems of Engineering and Technology. To apply the mathematical results and numerical techniques of optimization theory to concrete Engineering problems.

	CONTENTS	**Hrss**
UNIT-1	**Introduction:** Terminology, Design Variables, Constraints, Objective Function, Variable Bounds, Problem Formulation, Engineering Optimization Problems. Calculus method. Linear Programming. Simplex method, Concept of Duality.	10
UNIT-2	**Single Variable Optimization Problems:** Optimality Criterion, Bracketing Methods, Region Elimination Methods, Interval Halving Method, Fibonacci Search Method, Golden Section Method, Successive Quadratic Estimation Method. Gradient Based Methods: Newton-Raphson Method, Bisection Method, Secant Method. Application to Root finding.	10
UNIT-3	**Multivariable Optimization Algorithms:** Optimality Criteria, Unidirectional Search, Direct Search Methods: Hooke-Jeeves pattern search method, Powell's Conjugate Direction Method. Gradient Based Methods: Cauchy's Steepest Descent Method, Newton's method, Marquardt's Method.	10
UNIT-4	**Constrained Optimization Algorithms:** Kuhn Tucker conditions, Transformation Methods: Penalty Function Method, Method of Multipliers, Sensitivity analysis.	10

UNIT-5	**Topics in Optimization Techniques:** Quadratics Programming, sequential quadratic programming; Integer Programming, Penalty Function Method, Branch and Bound Method, Geometric Programming, Applications Design of experiments and Taguchi method – Application and problem solving; Dynamic programming, principle of optimality, recursive equation approach and applications; Genetic algorithm.	**12**

TEXT BOOKS:

1. S. S. Rao, **"Engineering Optimization: Theory and Practice",** John Wiley & Sons, 1996.

2. Kalyanmoy Deb, **"Optimization for Engineering Design: Algorithms and Examples",** 2nd ed, Prentice Hall of India, 2004.

REFERENCES BOOKS:

1. E. J. Haug and J. S. Arora, **"Applied Optimal Design",** Wiley, New York.
2. G.V. Reklaites, A. Ravindran and K.M. Rogsdeth, **"Optimization",** Wiley, New York.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)

CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

(Irrespective of portions covered due to whatever might be the reason)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO1	Formulate engineering optimization problem and solve LPP by simplex method.
CO2	Solve single and multivariable optimization problem by various relevant method.
CO3	Develop algorithm for constrained optimization.
CO4	Examine various optimization techniques and demonstrate their applicability.
CO5	Cast engineering minima/maxima problems into optimization framework.

MAPPING OF COs WITH Pos

COs/POs	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12
CO1	1	1	-	-	-	-	-	-	3	-	-	-
CO2	2	3	-	-	2	1	-	-	-	-	-	2
CO3	3	-	3	-	3	-	-	-	-	-	-	-
CO4	3	1	2	-	-	-	-	-	-	-	-	3

ADMISSION YEAR: 2019-20 **ACADEMIC YEAR: 2019-20**

COURSE TITLE: THEORY OF PLATES AND SHELLS		
Sub Code: 18MMD324	**No of Credits: L-T-P-SS** **4:0:0:0=4**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**
Pre-requisites	Mom, Theory of Elasticity, Theory of Plasticity	

<u>COURSE OBJECTIVES</u>:

Understand the classical structural mechanics approximations of Membrane, Plate and Shell theories. Apply energy formulations to demonstrate the consistent derivation of approximate boundary conditions and edge effects. Identify the necessary tools to describe static, dynamic and non-linear motions. Evaluate the buckling, vibration and stress parameters in thin shells using numerical approximation techniques.

	CONTENTS	**Hrss**
UNIT-1	**General Introduction:** Review of equations of elasticity- kinematics, compatibility equations, stress measures- equations of motions- constitutive relations- transformation of stresses, strains and stiffness-energy principles and variational methods in elasticity- virtual work-external and internal virtual work variational operator- functionals- Euler Lagrange equations- energy principles- Hamilton's principle- principle of minimum total potential- applications.	10
UNIT-2	**Classical Theory of Plates:** Plates as structural elements- stress and moment resultants- assumptions made in the classical theory- displacement fields and strains- equations of equilibrium in Cartesian coordinates and in polar coordinates- boundary conditions – bending of rectangular plates with various boundary conditions and loading- symmetrical and asymmetrical bending of circular plates-limitations of classical theory- finite element analysis	12
UNIT-3	**Buckling Analysis of Rectangular Plates:** Buckling of simply supported plates under compressive forces- governing equations- the Navier solution- biaxial compression of a plate- uniaxial compression of a plate- buckling of plates simply supported on two opposite edges- Levy's solution- buckling of plates with various boundary conditions- general formulation- finite element analysis	10
UNIT-4	**Vibration of Plates:** Governing equations for natural flexural vibrations of rectangular plates- natural vibrations of plates simply supported on all edges- vibration of plates with two parallel sides simply supported Levy's solution- vibration of plates with different boundary conditions- Rayleigh-Ritz method Natural vibration of plates with general boundary conditions- transient analysis of rectangular plates- finite element analysis	10

UNIT-5	**Analysis of Thin Elastic Shells of Revolution:** Classification of shell surfaces- geometric properties of shells of revolution- general strain displacement relations for shells of revolution-stress resultants- equations of motion of thin shells, analytical solution for thin cylindrical shells-membrane theory- flexure under axisymmetric loads, shells with double curvature- geometric considerations- equations of equilibrium- bending of spherical shells- vibration of cylindrical shells.	**10**

TEXT BOOKS:

1. Reddy, J.N., "**Theory and Analysis of Elastic Plates & Shells**", C.R.C. Press, NY, USA, 2nd Edition, ISBN 9780849384158
2. Timoshenko, S. and Krieger S.W. **Theory of Plates and Shells**, McGraw Hill Book Company, New York 1990, ISBN 0-13-913426-3

REFERENCES BOOKS:

1. Szilard, R., **Theory and Analysis of Plates,** Prentice Hall Inc., 1999, ISBN 0-12-9353336-2
2. Wilhelm Flügge, **Stresses in shells,** Springer –Verlag, ISBN 978-3-662-01028-0

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)

CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

(Irrespective of portions covered due to whatever might be the reason)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO1	Apply the structural mechanics approximations of membrane, plates and shells.
CO2	Develop simple modifications to the membrane plate and shell theories
CO3	Describe the static, dynamic, and non-linear motion of membrane, plate and shell structures.
CO4	Analyze numerical problems in shells of revolution.

MAPPING OF COs WITH Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	3	1	-	-	-	-	-	-	-
CO2	-	-	-	2	-	1	-	-	-	-	-
CO3	3	1	1	-	-	-	-	-	-	-	-
CO4	1	2	-	3	3	1	-	-	-	-	-

ADMISSION YEAR: 2019-20 **ACADEMIC YEAR: 2019-20**

COURSE TITLE: COMPUTER APPLICATIONS IN DESIGN		
Sub Code: 18MMD331	**No of Credits: L-T-P-SS** **4:0:0:0=4**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**
Pre-requisites	Mom, Finite Element Method.	

COURSE OBJECTIVES:

Memorize the equations of transformations, curves, solid models and surfaces. Understand the concept of computer Graphics. Demonstrate the principles of wire frame, Geometric, and surface modeling. Distinguish the different concepts of algorithm.

	CONTENTS	**Hrss**
UNIT-1	**Computer Graphics:** Line drawing algorithms: DDA, Bresenham's algorithms, Mid-point circle algorithms, coordinate systems, windowing, View generation, Clipping, Transformations of geometry.	10
UNIT-2	**Software Configuration:** Software configuration of a graphics system, Functions of a graphics package, Mathematics of projections, Hidden line removal, Hidden surface removal, Shading, Rendering. **Basics of geometry modeling:** Requirements of geometric modeling, geometric models, geometric construction methods, modeling facilities desired.	10
UNIT-3	**Wireframe Modeling:** Classification of wire frame entities, curve representation methods, parametric representation of analytic curves, curvature continuity, Lagrange interpolation, Parametric representation of synthetic curves, curve manipulations.	10
UNIT-4	**Solid Modeling:** Application of solid models, modeling considerations of solids, geometry and topology, solid modeling scheme, Boundary Representation, Winged edge data structure for Boundary representation, Euler operations, Constructive solid geometry, Sweeping, Solid Manipulations.	10
UNIT-5	**Surface modeling:** Introduction, Planes, Vector Planes, surface entities, Surface representation methods, Quadratic Surface in normal forms, Quadratic Surface in general forms, Quadratic Surface in matrix form, parametric surfaces, Parametric representation of analytic surfaces, Parametric representation of synthetic surfaces, Surface Manipulations.	**12**

TEXT BOOKS:

1. Chennakesava R Alavala **"CAD/CAM Concepts and Applications",** 1st Ed PHI, New Delhi, 2009.
2. P.N. Rao**, "CAD/CAM Principles and Applications",** 3rd Ed., McGraw Hill, Education Pvt Ltd.

REFERENCES BOOKS:

1. Ibrahim Zeid, **"Mastering CAD/CAM",** 2nd Ed., TMH Publishing Company Limited., New Delhi.
2. M.P. Groover and 3 E W Zimmers**, CAD/CAM Computer aided Design and Manufacturing**, 9^{th} Ed, 1993.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)

CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

(Irrespective of portions covered due to whatever might be the reason)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO1	Discuss the concepts of Computer Graphics in CAD in product development
CO2	Apply the concepts of CAD in the manufacturing industry
CO3	Analyze the concepts of computer Aided Design
CO4	Evaluating the techniques involved in CAD.

MAPPING OF COs WITH POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	3	3	-	-	-	-	-	-	-	-
CO2	3	2	2	1	-	-	-	-	-	-	-
CO3	1	3	-	3	2	-	-	-	-	-	-
CO4	-	-	1	2	3	1	-	-	-	-	-

- High-3
- Medium-2
- Low-1

ADMISSION YEAR: 2019-20 **ACADEMIC YEAR: 2019-20**

COURSE TITLE: ADVANCED SYSTEM DESIGN		
Sub Code: 18MMD332	**No of Credits: L-T-P-SS** **4:0:0:0=4**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**
Pre-requisites	Mom, Project Management, Engineering Economics.	

COURSE OBJECTIVES:

To study the basic concepts of different types of design. Need analysis in engineering systems
Analyze the concept of design with respect to economics and optimization.

	CONTENTS	**Hrss**
UNIT-1	**INTRODUCTION**: What is designing, Man as a designer: Design by evolution, inadequacies of traditional design method: System approach of engineering problems: Need models: design history of large-scale existing system. Morphology of Design: The three phases of design projects, the structure of design process, decision making and iteration.	10
UNIT-2	**Identification, Need analysis &Design Concept:** Preliminary need statement, analysis of need, specifications, and standards of performance and constraints. Process of idealization, mental fixity, analysis, AIDA, brain storming etc.	10
UNIT-3	**Preliminary Design:** Mathematical modeling for functional design: concept of sensitivity, compatibility and stability analysis. Evaluation Of Alternatives and Design Decisions.	10
UNIT-4	**Design Tree:** Quality of design, Concept of utility, multi criteria decisions, decisions under uncertainty and risk (Numerical), Bath tub curve, exponential reliability function, system reliability concept. (Numerical)	10
UNIT-5	**Economics And Optimization in Engineering Design**: Economics in Engineering Design, Fixed and variable costs, break-even analysis. (Numerical) Optimization: Introduction to LPP. Man, Machine Interaction, Designing for use and maintenance, Man-Machine Cycle, Design of displays and controls. Factors influencing displays and controls.	**12**

REFERENCES BOOKS:

1. **Mechanical System Design** by: W. E. Eder lecturer In Mechanical Engineering And's. Gosling
2. Harrison Kim, Dept. of Industrial and Enterprise Systems Engineering (ISE) - 2 - 1. Papa Lambros, P.Y. and Wilde, D., **Principles of Optimal Design** (2nd Ed.), Cambridge University Press, New York, 2000. 2.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)

CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

(Irrespective of portions covered due to whatever might be the reason)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO1	Analyze the types of design and concepts
CO2	Applying the concept of need-based design.
CO3	Implement preliminary design concept in real life.
CO4	Analyzing the process of design in the form of sequence of actions.

MAPPING OF COs WITH POs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO 1
1	3	--	-	-	-	-	-	-	-	1	-	2
2	2	-	3	-	1	-	3	-	-	-	-	-
3	3	3	2	-	-	-	-	-	-	-	-	-
4	3	3	2	1	-	-	-	-	-	-	-	-

- High-3
- Medium-2
- Low-1

ADMISSION YEAR: 2019-20 **ACADEMIC YEAR: 2019-20**

COURSE TITLE: DESIGN OF HYDRAULICS AND PNEUMATICS		
Sub Code: 18MMD333	**No of Credits: L-T-P-SS** **4:0:0:0=4**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**
Pre-requisites	Mom, Design of Machine Elements, Finite Element Method.	

COURSE OBJECTIVES:

Identify the symbolic representation of hydraulic systems. Understand the working of industrial systems employing fluid power. Identify the working of hydraulic circuits. Select the appropriate components through design calculations and demonstrate the electronic components in pneumatic systems.

	CONTENTS	Hrss
UNIT-1	**Hydraulic Actuators and Motors:** Pascal's law and problems on Pascal's Law, continuity equations, introduction to conversion of units. Structure of Hydraulic Control System Linear Hydraulic Actuators [cylinders], Mechanics of Hydraulic Cylinder loading, Hydraulic Rotary Actuators, Gear motors, vane motors, piston motors, Hydraulic motor theoretical torque, power and flow rate, and hydraulic motor performance.	10
UNIT-2	**Control Components in Hydraulic Systems:** Directional Control Valves – Symbolic representation, Constructional features, pressure control valves – direct and pilot operated types, flow control valves. **Hydraulic Circuit Design and Analysis:** Control of single and double – acting Hydraulic Cylinder, regenerative circuit, pump unloading circuit, Double pump Hydraulic system, Counter Balance Valve application, and Hydraulic cylinder sequencing circuits. Locked cylinder using pilot check valve, cylinder synchronizing circuits, speed control of hydraulic cylinder, speed control of hydraulic motors, accumulators and accumulator circuits.	12
UNIT-3	**Introduction to Pneumatic Control:** Choice of working medium, characteristics of compressed air. Structure of Pneumatic control system. Pneumatic Actuators: Linear cylinders – Types, conventional type of cylinder working, end position cushioning, seals, mounting arrangements applications. Rod–less cylinders, types, working advantages. Rotary cylinder types construction and application. Design parameters, selection.	10
UNIT-4	**Directional Control Valves:** Symbolic representation as per ISO 1219 and ISO 5599. Design and constructional aspects, poppet valves, slide valves spool valve, suspended seat type slide valve. Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, use of memory valve.	10

	Flow control valves and speed control of cylinders supply air throttling and exhaust air throttling use of quick exhaust valve. Signal processing elements: Use of Logic gates – OR and AND gates pneumatic applications. Practical examples involving the use of logic gates. Pressure dependent controls types construction–practical applications. Time dependent controls – Principle, construction, practical applications.	
UNIT-5	**Multi-cylinder Applications:** Coordinated and sequential motion control. Motion and control diagrams – Signal elimination methods. Cascading method – principle. Practical application examples (up to two cylinders) using cascading method (using reversing valves). Electro-Pneumatic control: Principles-signal input and output pilot assisted solenoid control of directional control valves, use of relay and contactors. Control circuitry for simple single cylinder applications. Compressed air: Production of compressed air – compressors, preparation of compressed air- Driers, Filters, Regulators, Distribution of compressed air- Piping layout.	**10**

TEXT BOOKS:

1. S.R. Majumdar **Oil Hydraulic Systems - Principles and Maintenance**, Tata Mc Graw Hill publishing company Ltd. 2001. ISBN- 10: 0074637487
2. S.R. Majumdar Pneumatic Systems, Tata Mc Graw Hill publishing Co., 1995. ISBN- 0074602314.

REFERENCES BOOKS:

1. Anthony Esposito **Fluid Power with applications**, Fifth edition Pearson education, Inc. 2000. ISBN- 10: 129202387
2. Andrew Parr **Pneumatics and Hydraulics**. Jaico Publishing Co. 2000. ISBN- 10: 0750644192

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;

CIE-1: UNIT 1 (100%) + UNIT 2 (100%)

CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)

CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)

(Irrespective of portions covered due to whatever might be the reason)

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO1	Illustrate and explain the significance hydraulic and pneumatic components.
CO2	Describe the symbolic representations of fluid power components in an industrial circuit.
CO3	Integrate and differentiate a function for given set of tabulated data with greater accuracy for engineering problems.
CO4	Evaluate the selection of valves for specific applications
CO5	Design and develop hydraulic and pneumatic based system for industrial applications.

MAPPING OF COs WITH POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	-	-	-	-	-	-	-	-	-	-
CO2	-	3	2	2	2	-	-	-	-	-	-
CO3	-	-	2	2	-	-	-	-	-	-	-
CO4	3	2	1	-	3	-	1	-	-	-	-

ADMISSION YEAR: 2019-20 **ACADEMIC YEAR: 2019-20**

COURSE TITLE: COMPUTATIONAL METHODS IN ENGINEERING ANALYSIS		
Sub Code: 18MMD334	**No of Credits: L-T-P-SS** **4:0:0:0=4**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**
Pre-requisites	Mom, Design of Machine Elements, Finite Element Method.	

COURSE OBJECTIVES:

The aim of the course is to equip an engineer with skills to develop mathematical models: It is an art of applying mathematics to complex real-world problems. The course combines mathematical theory, practical engineering and scientific computing to address today's technological challenges. It facilitates conversion of scientific statements into a form Engineers understand.

	CONTENTS	Hrss
UNIT-1	**Approximations and Round off Errors:** Significant figures, accuracy and precision, error definitions, round off errors and truncation errors. Mathematical modeling and Engineering problem solving, simple mathematical model, Conservation Laws of Engineering.	10
UNIT-2	**Roots of Equations:** Bracketing Methods-Graphical method, Bisection method, False position method, Newton- Raphson method, Secant Method. Multiple roots, Simple fixed-point iteration. **Roots of Polynomial:** Polynomials in Engineering and Science, Muller's method, Bairstow's Method Graeffe's Roots Squaring Method.	10
UNIT-3	**Numerical Differentiation and Numerical Integration:** Newton –Cotes and Gauss Quadrature Integration formulae, Integration of Equations, Romberg integration, Numerical Differentiation Applied to Engineering problems, High Accuracy differentiation formulae.	10
UNIT-4	**System of Linear Algebraic Equations and Eigen Value Problems:** Introduction, Direct methods, Cramer's Rule, Gauss Elimination Method, Gauss-Jordan Elimination Method, Triangularization method, Cholesky Method, Partition method, Error Analysis for direct methods, Iteration Methods. **Eigen values and Eigen Vectors:** Bounds on Eigen Values, Jacobi method for symmetric matrices, Givens method for symmetric matrices, Rutishauser method for arbitrary matrices, Power method, Inverse power method.	12

UNIT-5	**Linear Transformation:** Introduction to Linear Transformation, The matrix of Linear Transformation, Linear Models in Science and Engineering **Orthogonality and Least Squares**: Inner product, length and orthogonality, orthogonal sets, Orthogonal projections, The Gram-Schmidt process, Least Square problems, Inner product spaces.	**10**

TEXT BOOKS:

3. Steven C. Chapra, Raymond P. Canale **"Numerical Methods for Engineers**"- 5th Edition, Tata McGraw Hill, 2007.
4. S. S. Sastry "**Introductory Method of Numerical Analysis**", PHI, 2009.
5. M K. Jain, S.R.K Iyengar, R K. Jain "**Numerical Methods for Scientific and Engg. Computation**". New Age International, 2003.

REFERENCES BOOKS:

3. Perviz Moin **"Fundamentals of Engineering Numerical Analysis",** Cambridge, 2010.
4. David. C. Lay, **"Linear Algebra and its applications"** -3rd edition, Pearson Education, 2005.
5. Laurence V Fausett, **"Applied Numerical Analysis using MATLAB"**, Pearson, 2008.

REMINDER

BREAK-UP OF COURSE CONTENTS FOR;
CIE-1: UNIT 1 (100%) + UNIT 2 (100%)
CIE-2: UNIT 3 (100%) + UNIT 4 (FIRST 50%)
CIE-3: UNIT 4 (NEXT 50%) + UNIT 5 (100%)
(Irrespective of portions covered due to whatever might be the reason)
QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	

SCHEME OF EXAMINATION (SEE)

1. Ten Full Questions to be set.
2. Five full Questions to be answered.
3. Students shall answer Q1 or Q2 from Unit-1, Q3 or Q4 from Unit-2, Q5 or Q6 from Unit-3, Q7 or Q8 from Unit-4, Q9 or Q10 from Unit-5 with two questions from each Unit.
4. Each question shall contain maximum of 2 subdivisions
5. Each main question carries equal Marks.

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO1	Construct and analyze mathematical models of physical applications.
CO2	Find the roots of polynomials, algebraic, transcendental or simultaneous system of equations in science and engineering problems.
CO3	Integrate and differentiate a function for given set of tabulated data with greater accuracy for engineering problems.
CO4	Solve system of linear algebraic equations and compute eigen values and eigen vectors of matrices.
CO5	Demonstrate use of computational tools like MAT Lab to obtain solution to complex mathematical models.

MAPPING OF COs WITH POs

COs/POs	**po1**	**po2**	**po3**	**po4**	**po5**	**po6**	**po7**	**po8**	**po9**	**po10**	**po11**	**po12**
CO1	2	-	-	-	2	-	3	-	-	-	-	-
CO2	2	3	3	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-
CO4	3	3	2	-	-	-	-	1	-	-	-	-

INTERNSHIP-18MMDI34

Internship: The student shall undergo internship for 16 weeks.

Preliminary Report submission and Evaluation after 8th week of Internship to be carried out by the Internal Guide of the college and a senior faculty for 100 marks

Final Report submission and Evaluation after 16th week of Internship to be carried out by the Internal Guide of the college and a senior faculty of Dept. Report Evaluation to be completed within two weeks of submission for 100 marks.

Viva-Voce on Internship - To be conducted by the Internship Guide (from the college) and the External Guide / Examiner within 2 weeks of Submission with a senior faculty / HoD as chairman for 100 marks

COURSE TITLE: Modelling & Analysis Lab		
Sub Code: 18MMDL35	**No of Credits: L-T-P-SS** **1:0:3:0=4**	**No. of Lecture hours/week :03**
Exam Duration:3 hours	**CIE Marks: 50**	**Exam Marks :50**
Pre-requisites	Design and vibration knowledge.	

Note:

1) These are independent laboratory exercises
2) A student may be given one or two problems stated herein
3) Student must submit a comprehensive report on the problem solved and give a Presentation on the same for Internal Evaluation
4) Any one of the exercises done from the following list has to be asked in the Examination for evaluation.

Course Content:

Experiment #1 Structural Analysis

Part A: FE Modeling of a stiffened Panel using a commercial preprocessor.

Part B: Buckling, Bending and Modal analysis of stiffened Panels.

Part C: Parametric Studies.

Experiment #2 Design Optimization

Part A: Shape Optimization of a rotating annular disk.

Part B: Weight Minimization of a Rail Car Suspension Spring.

Part C: Topology Optimization of a Bracket.

Experiment #3 Thermal analysis

Part A: Square Plate with Temperature Prescribed on one edge and Opposite edge insulated.

Part B: A Thick Square Plate with the Top Surface exposed to a Fluid at high temperature, Bottom Surface at room temperature, Lateral Surfaces Insulated.

Experiment #4 Thermal Stress Analysis

Part A: A Thick-Walled Cylinder with specified Temperature at inner and outer Surfaces.

Part B: A Thick-Walled Cylinder filled with a Fluid at high temperature and Outer Surface exposed to atmosphere.

Experiment#5 CFD Analysis

Part A: CFD Analysis of a Hydro Dynamic Bearing using commercial code.

Part B: Comparison of predicted Pressure and Velocity distributions with Target solutions.

Part C: Experimental Investigations using a Journal Bearing Test Rig.

Part D: Correlation Studies.

Experiment #6 Welded Joints.

Part A: Fabrication and Testing.

Part B: FE Modeling and Failure Analysis.

Experiment #7 Bolted Joints.

Part A: Fabrication and Testing.

Part B: FE Modeling and Failure Analysis.

Part C: Correlation Studies.

Experiment #8 Adhesive Bonded Joints.

Part A: Fabrication and Testing.

Part B: FE Modeling and Failure Analysis.

Part C: Correlation Studies.

Course Outcomes:

Upon completion of this course, the student will be able to

CO1	Acquire knowledge of stresses, strains and failure theories and analyze them in terms of mathematical models.
CO2	Design and conduct experiments involving photo elasticity and strain gauges.
CO3	Apply Experimental techniques for different engineering problems.
CO4	Use Finite element analysis software and make comparison with other techniques.

COURSE TITLE: TECHANICAL SEMINAR		
Sub Code: 18MMDS36	**No of Credits: L-T-P-SS** **0:0:2:0=2**	**No. of Lecture hours/week :02**
CIE Marks: 50		

Course Outcomes:

Upon completion of this course, the student will be able to

CO1	Identify and understand current trends and real-world issues related to topics in Machine Design.
CO2	Classify appropriate content and sources, through literature survey, that can be summarized and integrated into presentation
CO3	Review, analyze, and interpret data & results using critical thinking skills
CO4	Revise and present scientific case studies in presentation
CO5	Collaborate effectively with other students in analyzing results and preparing oral presentations
CO6	Prepare a technical seminar report and communicate effectively through oral presentation using multimedia tools

III SEMESTER

PROJECT PHASE: I 18MMDP37

Problem formulation and submission of **synopsis** within 8 weeks from the commencement of 3rd semester, which shall be evaluated for 50 marks by the committee constituted for the purpose by the Head of the Department comprising the guide, senior faculty of the department with HoD as Chairman.

Literature survey and progress done after 16 weeks shall be evaluated by guide and external examiner with senior faculty / HoD as chairman for 50 marks.

IV SEMESTER

- **Project Phase-II** - Internal Evaluation of progress in Project work shall be evaluated after 8 weeks for 25 marks by the committee constituted for the purpose by the Head of the Department comprising the guide and senior faculty of the department with HoD as Chairman
- **Project Phase-III** - Internal Evaluation of Project Demonstration, which shall be evaluated after 15 weeks for 25 marks by the committee constituted for the purpose by the Head of the Department.
- **Final Evaluation of Project Work and Viva-voce**.
  - Final evaluation of project to be carried out after 16 weeks from the date of commencement of 4th semester.
  - The Internal Examiner (the project guide with a teaching experience of at least three years) and External Examiner with HoD as chairman will complete the final evaluation of Project.
- Internal and External Examiners shall carry out the evaluation for 100 Marks each and the average of these marks shall be the final marks of the Project Evaluation.
- **Viva – Voce:** The Viva-Voce shall be conducted jointly by Internal Examiner and External Examiner with HoD as chairman for 100 Marks.

ADMISSION YEAR : 2021-22 **ACADEMIC YEAR: 2021-22**
SEMESTER : FIRST

COURSE TITLE:ADVANCED MECHANICS OF SOLIDS		
Sub Code: 20MMD12	**No of Credits : L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :04**
Exam Duration:3 Hours	**CIE Marks: 50**	**SEE Marks :50**

COURSE OBJECTIVES:

1. To study the basic concept of stress, stress distribution, elastic constants when the material is subjected to loading within the elastic limits.
2. Study the stress distribution in plane, polar and cylindrical coordinate system.
3. Analyze the material or component subjected to torsion of circular and non-circular shafts (elliptical, triangular bars)
4. Study the thermo-elastic properties of the material at elevated temperatures.

#	CONTENTS	Hrs
UNIT-1	**Introduction to general theory of elasticity:** assumptions and applications of linear elasticity. Analysis of stress, stress tensors. State of stress at a point, principal stresses in two dimensions, Cauchy's stress principle, direction cosines, stress components on an arbitrary plane with stress transformation. Principal stresses in three dimensions, stress invariants, Equilibrium equations, octahedral stresses, Mohr's stress circle, construction of Mohr's Circle for two and three dimensional stress systems, equilibrium equations in polar coordinates for three-dimensional state of stresses.	**11**
UNIT-2	**Introduction to analysis of strain**, types of strain, strain tensors, strain transformation. Principal strains, strain invariants, octahedral strains, Mohr's Circle for Strain, equations of Compatibility for Strain, strain rosettes. Stress-strain relations, the Generalised Hooke's law, compatibility conditions, the transformation from Strain components to stress components. Strain energy in an elastic body, St.Venant's principle, uniqueness theorem.	**11**
UNIT-3	**Theories of Failure and Energy Methods:** Introduction, Theories of Failure, Use of Factor of Safety in Design, Mohr's theory of Failure, Ideally Plastic Solid, Stress space and Strain space, General nature of Yield locus, Yield Surfaces of Tresca and Von Mises, Stress- Strain relation (Plastic Flow), Prandtl Reuss theory, Saint venant – Von mises equations. **Principle of Superposition,** Reciprocal Relation, Maxwell-Betti-Rayleigh Reciprocal theorem, First theorem of Castigliano, Expressions for Strain Energy, Statically indeterminate structures, Theorem of Virtual Work, Second theorem of Castigliano, Maxwell – Mohr integrals.	**10**
UNIT-4	**Bending of Beams:** Introduction, Straight beams and Asymmetrical Bending, Euler – Bernoulli hypothesis, Shear centre or Centre of Flexure, Shear stresses in thin walled open sections, Bending of curved beams, Deflection of thick curved bars.	**10**
UNIT-5	**Torsion:** Introduction, Torsion of general prismatic bars – Solid sections, Torsion of Circular and Elliptical bars, Torsion of equivalent triangular bar, Torsion of rectangular bars, Membrane analogy, Torsion of thin walled tubes, Torsion of thin walled multiple cell closed sections, Multiple connected sections, Centre of twist and flexure centre	**10**

TEXT BOOKS:

1. Advanced Mechanics of solids, L. S. Srinath, Tata Mc. Graw Hill, 2003.
2. Theory of Elasticity, S. P. Timoshenko and J. N Gordier, Mc.Graw Hill International, 3rd edition, 1972.

REFERENCES BOOKS:

1. Theory of Elasticity, Dr. Sadhu Singh, Khanna Publications, 1988
2. Elasticity, Theory, Applications & Numericals, Martin H Sadd, Elsevier. 2005.
3. Applied Elasticity, Seetharamu & Govindaraju, Interline Publishing.
4. Applied Elasticity, C.T. WANG Sc. D. Mc. Graw Hill Book Co.1953.

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	Apply basic concepts in continuum mechanics of solids viz. Stress and strain tensors, equilibrium, compatibility and constitutive equations and methods of solution to elasticity problems.
CO2	Evaluate stresses and displacements in simple solids such as pressurized cylinders, shrink fitted cylinders, rotating disc and shaft, plate with hole and non-circular shafts and thin tubes under torsion.
CO3	Examine bodies subjected to three dimensional stresses for the onset of failure based on failure Criteria.
CO4	Analyze deflections in beams subjected to different types of loads for elastic, elastoplastic and plastic conditions.
CO5	Evaluate stresses in bars subjected to torsion for elastic, elasto plastic and plastic conditions.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1			1				1			
CO2		1		1	1				1		1	
CO3	1		1		1						1	
CO4	1		1		1				1			
CO5	1		1						1		1	

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 **ACADEMIC YEAR: 2021-22**
SEMESTER : FIRST

COURSE TITLE: FINITE ELEMENT METHOD		
Sub Code: 20MMD13	**No of Credits : L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**SEE Marks :50**
Pre-requisites	MOM, Design of Machine Elements.	

COURSE OBJECTIVES:

1. To present the Finite element method (FEM) as a numerical method for engineering analysis of continuum and structures.
2. To present Finite element formulation using variation and weighted residual approaches.
3. To present Finite elements for the analysis of bars & trusses, beams & frames, plane stress & plane strain problems and 3-D solids, for thermal and dynamics problems.
4. Learn to model complex geometry problems and technique of solutions.

#	CONTENTS	Hrs
UNIT-1	**Introduction to Finite Element Method**: basic steps in finite element method to solve mechanical engineering problems (solid, fluid and heat transfer). Functional approach and Galerkin approach. Displacement approach: admissible functions. Convergence criteria: conforming and nonconforming elements, C0, C1 and Cn continuity elements. Basic equations, element characteristic equations, assembly procedure, boundary and constraint conditions.	**11**
UNIT-2	**Solid Mechanics:** One-dimensional finite element formulations and analysibars- uniform, varying and stepped cross section. Basic (Linear) and higher order elements formulations for axial, torsional and temperature loads with problems. **Beams**- basic (linear) element formulation-for uniform, varying and stepped cross section- for different loading and boundary conditions, numericals. **Trusses, Plane frames and Space frame** – basic (Linear) elements formulations for different boundary conditions -axial, bending, torsional, and temperature loads, numericals.	**11**
UNIT-3	**Two dimensional finite element formulations for solid mechanics problems**: triangular membrane (tria 3, tria 6, tria 10) element, fournoded quadrilateral membrane (quad 4, quad 8) element formulations for in-plane loading with simple problems. Triangular and quadrilateral axi-symmetric basic and higher order elements formulation for axi-symmetric loading with simple numericals. **Three dimensional finite element formulations for solid mechanics problems**: finite element formulation of tetrahedral element (tet 4, tet 10), hexahedral element (hexa 8, hexa 20), for different loading conditions. Serendipity and Lagrange family elements.	**10**
UNIT-4	**Finite element formulations for structural mechanics problems:** Basics of plates and shell theories: classical thin plate theory, shear deformation theory and thick plate theory. Finite element formulations for triangular and quadrilateral plate elements. Finite element formulation of flat, curved, cylindrical and conical shell elements.	**10**
UNIT-5	**Dynamic analysis:** finite element formulation for point/lumped mass and distributed masses system, finite element formulation of one dimensional dynamic analysis: bar, truss, frame and beam element. Finite element formulation of two dimensional dynamic analysis: triangular membrane and axi-symmetric element, quadrilateral membrane and axi-symmetric element. Evaluation of eigen values and eigen vectors applicable to bars, shaft, beams, plane and space frame.	**10**

TEXT BOOKS:

1. T. R. Chandrupatla and A. D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall, 3rd Ed, 2002.
2. Lakshminarayana H. V., Finite Elements Analysis– Procedures in Engineering, Universities Press, 2004.

REFERENCE BOOKS:

1. Rao S. S, Finite Elements Method in Engineering- 4th Edition, Elsevier, 2006
2. P.Seshu, Textbook of Finite Element Analysis, PHI, 2004.
3. J.N.Reddy, Introduction to Finite Element Method, mcgraw -Hill, 2006.
4. Bathe K. J, Finite Element Procedures, Prentice-Hall, 2006.
5. Cook R. D., Finite Element Modeling for Stress Analysis, Wiley, 1995.

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	Understand the concepts of Variation methods and Weighted residual methods.
CO2	Identify the application and characteristics of FEA elements such as bars, beams, plane and isoparimetric elements, and 3D element.
CO3	Develop element characteristic equations and generate global stiffness equations.
CO4	Apply suitable boundary conditions to a global structural equation, and reduce it to a solvable form.
CO5	Identify how the finite element method expands beyond the structural domain, for problems involving dynamics and heat transfer.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1		1					1			
CO2	1		1		1				1		1	
CO3	1		1						1		1	
CO4		1		1					1		1	
CO5	1	1			1						1	
High-3 Medium-2 Low-1												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 **ACADEMIC YEAR: 2021-22**
SEMESTER : FIRST

COURSE TITLE: ADVANCED DESIGN OF MECHANISM		
Sub Code: 20MMD14	**No of Credits : L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**SEE Marks :50**
Pre-requisites	MOM, Design of Machine Elements.	

COURSE OBJECTIVES:

1. To provide a theoretical and practical foundation for analysis and design of articulated mechanical systems for desired applications.
2. Develop skills to analyze the displacement, velocity, and acceleration of mechanisms.
3. Improve understanding of the synthesis of mechanisms for given tasks.
4. To include dynamics for considerations in the design of mechanisms engineering applications.

#	CONTENTS	Hrs.
UNIT-1	**Geometry of Motion:** Introduction, analysis and synthesis, Mechanism terminology, planar, spherical and spatial mechanisms, mobility, Grashoffs law, Equivalent mechanisms, Unique mechanisms, Kinematic analysis of plane mechanisms: Development of different mechanisms and its inversions like four bar chain mechanism, slider crank mechanism, double slider cranks, mechanism.	**11**
UNIT-2	**Generalized Principles of Dynamics:** Fundamental laws of motion, Generalized coordinates, Configuration space, Constraints, Virtual work, Principle of Virtual Work, Energy and Momentum, Work and kinetic energy, Equilibrium and stability, Kinetic energy of a system, Angular momentum, Generalized momentum. Lagrange's Equation: Lagrange's equation from D'Alembert's principles, Examples, Hamilton's equations, Hamilton's principle, Lagrange's, equation from Hamilton's principle, Derivation of Hamilton's equations, Examples.	**11**
UNIT-3	**Analytical Methods of Dimensional Synthesis:** Synthesis of Linkages: Type, number, and dimensional synthesis, Function generation, Path generation and Body guidance, Precision positions, Structural error, Chebychev spacing, Two position synthesis of slider crank mechanisms, Crank-rocker mechanisms with optimum transmission angle Motion Generation: Poles and relative poles, Location of poles and relative poles, polode, Curvature, Inflection circle.	**10**
UNIT-4	**Graphical Methods of Dimensional Synthesis**: Two position synthesis of crank and rocker mechanisms, Three position synthesis, Four position synthesis (point precision reduction) Overlay method, Coupler curve synthesis, Cognate linkages. Ana1ytical Methods of 32 Dimensional Synthesis: Freudenstein's equation for four bar mechanism and slider crank mechanism, Examples, Bloch's method of synthesis, Analytical synthesis using complex algebra.	**10**
UNIT-5	**Spatial Mechanisms:** Introduction, Position analysis problem, Velocity and acceleration analysis, Eulerian angles.	**10**

TEXT BOOKS:

1. K.J.Waldron&G.L.Kinzel , "Kinematics, Dynamics and Design of Machinery", Wiley India, 2007.
2. Greenwood, "Classical Dynamics", Prentice Hall of India, 1988.

REFERENCES BOOKS:

1. J E Shigley, "Theory of Machines and Mechanism" -McGraw-Hill, 1995
2. A.G.Ambekar , "Mechanism and Machine Theory", PHI, 2007.
3. Ghosh and Mallick , "Theory of Mechanism and Mechanism", East West press 2007.
4. David H. Myszka , "Machines and Mechanisms", Pearson Education, 2005.

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	The knowledge of dynamics considerations in mechanism design is essential to use commercial multi body dynamics software in mechanical engineering design.
CO2	Carry out mobility analysis of mechanism and perform velocity and acceleration of complex planer mechanism.
CO3	Synthesize mechanisms for function generation and path generation.
CO4	Analyze the Dynamics of Mechanical systems using D'Alemberts. ,Lagrange's, and Hamiltons Principles.
CO5	Demonstrate the skills to use software to analyze mechanisms, synthesis of linkages.

MAPPING OF COs WITH POs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1		1		1				1		1	
CO2	1	1		1							1	
CO3	1				1		1		1			
CO4	1		1	1							1	
CO5	1			1			1		1			
High-3 Medium-2 Low-1												

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 **ACADEMIC YEAR: 2021-22**

SEMESTER : FIRST

COURSE TITLE:EXPERIMENTAL METHODS		
Sub Code: 20MMD151	**No of Credits : L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**SEE Marks :50**
Pre-requisites	MOM, Design of Machine Elements.	

COURSE OBJECTIVES:

1. To introduce the concepts of dynamic measurements and analysis of experimental data.
2. To expose them to the techniques of Data Acquisition, Signal conditioning and processing.
3. To introduce students to different aspects of measuring deformation, strains, and stresses for developing a mechanistic understanding of both the material and the structure behavior.

#	CONTENTS	Hrs
UNIT-1	**Introduction:** Definition of terms, calibration, standards, dimensions and units, generalized measurement system, Basic concepts in dynamic measurements, system response, distortion, impedance matching, experiment planning. Analysis of Experimental Data: Cause and types of experimental errors, error analysis. Statistical analysis of experimental data- Probability distribution, gaussian, normal distribution. Chi-square test, Method of least square, correlation coefficient, multivariable regression, standard deviation of mean, graphical analysis and curve fitting, general consideration in data analysis.	**11**
UNIT-2	**Data Acquisition and Processing:** General data acquisition system, signal conditioning revisited, data transmission, Analog-to-Digital and Digital-to-Analog conversion, Basic components (storage and display) of data acquisition system. Computer program as a substitute for wired logic. Force, Torque and Strain Measurement: Mass balance measurement, Elastic Element for force measurement, torque measurement. Strain Gages -Strain sensitivity of gage metals, Gage construction, Gage sensitivity and gage factor, Performance characteristics, Environmental effects Strain, gage circuits, Potentiometer, Wheat Stone's bridges, Constant current circuits. Strain Analysis Methods-Two element and three element, rectangular and delta rosettes, Correction for transverse strains effects, stress gage - plane shear gage, Stress intensity factor gage.	**11**
UNIT-3	**Stress Analysis**: Two Dimensional Photo elasticity - Nature of light, - wave theory of light,- optical interference - Polariscopes stress optic law - effect of stressed model in plane and circular Polariscopes, IsoclinicsIso chromatics fringe order determination - Fringe multiplication techniques - Calibration Photoelastic model materials. Separation methods shear difference method, Analytical separation methods, Model to prototype scaling.	**10**
UNIT-4	**Three Dimensional Photo elasticity:** Stress freezing method, General slice, Effective stresses, Stresses separation, Shear deference method, Oblique incidence method Secondary principals stresses, Scattered light photo elasticity, Principals, Polari scope and stress data analyses.	**10**
UNIT-5	**Coating Methods:** **Photo elastic Coating Method**-Birefringence coating techniques Sensitivity Reinforcing and thickness effects - data reduction - Stress separation techniques Photo elastic strain gauges. **Brittle Coatings Method:** Brittle coating technique Principles data analysis - coating materials, Coating techniques. **Moire Technique** - Geometrical approach, Displacement approach-	**10**

	sensitivity of Moire data data reduction, In plane and out plane Moire methods, Moire photography, Moire grid production. Holography: Introduction, Equation for plane waves and spherical waves, Intensity, Coherence, Spherical radiator as an object (record process), Hurter, Driffeld curves, Reconstruction process, Holograpic interferomerty, Real time. and double exposure methods, Displacement measurement, Isopachics.	

TEXT BOOKS:

1. Holman,"Experimental Methods for Engineers" 7th Edition, Tata McGraw-Hill Companies, Inc, New York, 2007.
2. R. S. Sirohi, H. C. Radha Krishna, "Mechanical measurements" New Age International Pvt. Ltd., New Delhi, 2004 .
3. Experimental Stress Analysis - Srinath, Lingaiah, Raghavan, Gargesa, Ramachandra and Pant, Tata McGraw Hill, 1984.
4. Instrumentation, Measurement And Analysis -Nakra&Chaudhry, B C Nakra K KChaudhry, Tata McGraw-Hill Companies, Inc, New York, Seventh Edition, 2006.

REFERENCES BOOKS:

1. Measurement Systems Application and Design - Doeblin E. A., 4th (S.I.) Edition, McGraw Hill, New York. 1989 .
2. Design and Analysis of Experiments - Montgomery D.C., John Wiley & Sons, 1997.
3. Experimental Stress Analysis-Dally and Riley, McGraw Hill, 1991.
4. Experimental Stress Analysis-Sadhu Singh, Khanna publisher, 1990. 5. PhotoelasticityVol I and Vol II - M.M.Frocht,. John Wiley and sons, 1969. 6. Strain Gauge Primer - Perry and Lissner, McGraw Hill, 1962.

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	Undertake experimental investigations to verify predictions by other methods.
CO2	To acquire skills for experimental investigations an accompanying laboratory course is desirable.
CO3	To analyze fringe patterns, calibration studies.
CO4	Analysis and evaluations of polariscope.
CO5	Study and evaluation techniques of coating technology.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1		1		1				1		1	
CO2		1			1				1		1	
CO3	1				1				1		1	
CO4	1		1	1					1			
CO5		1		1				1			1	
High-3 Medium-2 Low-1												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 ACADEMIC YEAR: 2021-22

SEMESTER : FIRST

COURSE TITLE : MECHATRONICS SYSTEMS DESIGN

Sub Code: 20MMD152	No of Credits : L-T-P-SS 3:0:0:0 =3	No. of lecture hours/week : 04
Exam Duration : 3 hours	CIE Marks: 50	SEE Marks :50

COURSE OBJECTIVES:

1. To educate the student regarding integration of mechanical, electronic, electrical and computer systems in the design of CNC machine tools, Robots etc.
2. To provide students with an understanding of the Mechatronic Design Process, actuators, Sensors, transducers, Signal Conditioning, MEMS and Microsystems and also the Advanced Applications in Mechatronics

#	CONTENTS	Hrs
UNIT-1	**INTRODUCTION:** Definition and Introduction to Mechatronic Systems. Modeling &Simulation of Physical systems Overview of Mechatronic Products and their functioning, measurement systems. Control Systems, simple Controllers.	**11**
UNIT-2	**STUDY OF SENSORS AND TRANSDUCERS:** Pneumatic and Hydraulic Systems, Mechanical Actuation System, Electrical Actual Systems, Real time interfacing and Hardware components for Mechatronics.	**11**
UNIT-3	**ELECTRICAL ACTUATION SYSTEMS:** Electrical systems, Mechanical switches, Solid state switches, solenoids, DC & AC motors, Stepper motors. **System Models:** Mathematical models:- mechanical system building blocks, electrical system building blocks, thermal system building blocks, electromechanical systems, hydro-mechanical systems, pneumatic systems.	**10**
UNIT-4	**SIGNAL CONDITIONING:** Signal conditioning, the operational amplifier, Protection, Filtering, Wheatstone Bridge, Digital signals , Multiplexers, Data Acquisition, Introduction to digital system processing, pulse-modulation. **MEMS AND MICROSYSTEMS:** Introduction, Working Principle, Materials for MEMS and Microsystems, Micro System fabrication process, Overview of Micro Manufacturing, Micro system Design, and Micro system Packaging.	**10**
UNIT-5	**DATA PRESENTATION SYSTEMS:** Basic System Models, System Models, Dynamic Response of system. **ADVANCED APPLICATIONS IN MECHATRONICS:** Fault Finding, Design, Arrangements and Practical Case Studies, Design for manufacturing, User-friendly design.	**10**

TEXT BOOKS:

1. W. Bolton, “Mechatronics” - Addison Wesley Longman Publication, 1999
2. HSU “MEMS and Microsystems design and manufacture”- Tata McGraw-Hill Education, 2002

REFERENCE BOOKS:

1. Kamm,“Understanding Electro-Mechanical Engineering an Introduction to Mechatronics”- IEEE Press, 1 edition ,1996
2. Shetty and Kolk, “Mechatronics System Design”- Cenga ge Learning, 2010
3. Mahalik ,“Mechatronics”- Tata McGraw-Hill Education, 2003
4. HMT “Mechatronics”- Tata McGraw-Hill Education, 199 8
5. Michel .B. Histand& David. Alciatore, “Introduction to Mechatronics & Measurement Systems”–. Mc Graw Hill, 2002.

COURSE OUTCOME: After the completion of this course, student will be able to:

CO1	Appreciate multi-disciplinary nature of modern engineering systems.
CO2	Model and analyze mechanical and electrical systems and their connection.
CO3	Be able to integrate mechanical, electronics, control and computer engineering in the design of mechatronics systems.
CO4	Address issues of design, fabrication, and packaging issues of Microsystems.
CO5	Design of system models in application of advanced mechatronics system.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1		1		1				1		1	
CO2		1	1	1					1			
CO3	1			1					1		1	
CO4		1	1						1		1	
CO5	1		1	1							1	
High-3 Medium-2 Low-1												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 **ACADEMIC YEAR: 2021-22**
SEMESTER : FIRST

COURSE TITLE: DESIGN FOR ADDITIVE MANUFACTURING

Sub Code: 20MMD153	No of Credits : L-T-P-SS 3:0:0:0=3	No. of Lecture hours/week :04
Exam Duration:3 hours	CIE Marks: 50	SEE Marks :50

COURSE OBJECTIVES:

1. To acquaint the learner on fundamentals of additive manufacturing/rapid prototyping, reverse engineering techniques and its applications.
2. To familiarize students with different processes in rapid prototyping systems.
3. To teach students about mechanical properties and geometric issues relating to specific rapid prototyping applications.

#	CONTENTS	Hrs
UNIT-1	**Introduction:** Need for the compression in product development, history of RP systems, Survey of applications, Growth of RP industry, and classification of RP systems. **Stereo Lithography Systems:** Principle, Process parameter, Process details, Data preparation, data files and machine details, Application.	**11**
UNIT-2	**Selective Laser Sintering and Fusion Deposition Modeling:** Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications, Principle of Fusion deposition modeling, Process parameter, Path generation, Applications.	**11**
UNIT-3	**Solid Ground Curing:** Principle of operation, Machine details, Applications. **Laminated Object Manufacturing:** Principle of operation, LOM materials. Process details, application.	**10**
UNIT-4	**Rapid Tooling:** Indirect Rapid tooling -Silicone rubber tooling – Aluminum filled epoxy tooling Spray metal tooling, Cast kirksite, 3Q keltool, Direct Rapid Tooling Direct. AIM, Quick cast process, Copper polyamide, Rapid Tool, DMILS, Prometal, Sand casting tooling, Laminate tooling soft Tooling vs. hard tooling.	**10**
UNIT-5	**RP Process Optimization:** factors influencing accuracy. Data preparation errors, Part building errors, Error in finishing, influence of build orientation.	**10**

REFERENCES BOOKS:

1. Stereo lithography and other RP & M Technologies -Paul F. Jacobs- SME, NY1996
2. Rapid Manufacturing - Flham D.T &Dinjoy S.S - Verlog London2001.
3. Rapid automated - Lament wood - Indus press NewYork
4. Wohler's Report 2000 - Terry Wohlers - Wohler's Association -2000

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	Describe product development, conceptual design and classify rapid prototyping systems; explain stereo lithography process and applications
CO2	Explain direct metal laser sintering, LOM and fusion deposition modeling processes.
CO3	Demonstrate solid ground curing principle and process.
CO4	Discuss LENS, BPM processes, point out the application of RP system in medical field define virtual prototyping and identify simulation components.

CO5	Understand the RP Process Optimizations.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1			1		1			1		1	
CO2		1	1		1						1	
CO3	1		1			1			1		1	
CO4		1			1				1		1	
CO5	1	1			1						1	

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 ACADEMIC YEAR: 2021-22
SEMESTER : FIRST

COURSE TITLE: MATERIAL HANDLING EQUIPMENT DESIGN		
Sub Code: 20MMD154	**No of Credits : L-T-P-SS**	**No. of Lecture hours/week :04**

	3:0:0:0=3	
Exam Duration:3 hours	**CIE Marks: 50**	**SEE Marks :50**

COURSE OBJECTIVES:

1. To develop competency for system visualization and design.
2. To enable student select materials and to design internal engine components.
3. To acquaint student to optimum design and use optimization methods to design mechanical components.
4. To enable and evaluate design material handling systems

#	CONTENTS	Hrs
UNIT-1	**Elements of Material Handling System:** Importance, Terminology, Objectives and benefits of better Material Handling; Principles and features of Material Handling System; Classification of Material Handling Equipment's, Interrelationships between material handling and plant layout, physical facilities and other organizational functions.	**11**
UNIT-2	**Selection of Material Handling Equipment's:** Factors affecting for selection; Material Handling Equation; Choices of Material Handling Equipment; General analysis Procedures; Basic Analytical techniques; The unit load concept; Selection of suitable types of systems for applications ; Activity cost data and economic analysis for design of components of Material Handling Systems; functions and parameters affecting service; packing and storage of materials.	**11**
UNIT-3	**Design of Mechanical Handling Equipment's:** **Design of Hoists: Drives for hoisting**, components, and hoisting mechanisms; rail traveling components and mechanisms; hoisting gear operation during transient motion; selecting the motor rating and determining breaking torque for hoisting mechanisms. **Design of Cranes:** Hand-propelled and electrically driven E.O.T. overheat Traveling cranes; Traveling mechanisms of cantilever and monorail cranes; design considerations for structures of rotary cranes with fixed radius ; fixed post and overhead traveling cranes; Stability of stationary rotary and traveling rotary cranes.	**10**
UNIT-4	**Study of systems and Equipment's used for Material Storage:** Objectives of storage; Bulk material handling; Gravity flow of solids through slides and chutes; Storage in bins and hoppers; Belt conveyors; Bucket-elevators; Screw conveyors; Vibratory Conveyors; Cabin conveyors; Mobile racks etc.	**10**
UNIT-5	**Material Handling / Warehouse Automation and Safety considerations:** **Storage and warehouse planning and design:** computerized warehouse planning; Need, Factors and Indicators for consideration in warehouse automation; which function, When and How to automate; Levels and Means of Mechanizations. **Safety and design;** Safety regulations and discipline.	**10**

TEXT BOOKS:

1. Materials Handling Equipment – N. Rudenko , Envee Publishers, New Delhi
2. Materials Handling Equipment – M.P. Alexandrov. Mie publications, Moscow

REFERENCE BOOKS:

1. Aspects of Material handling – Arora
2. Introduction to Material Handling- Ray
3. Plant Layout and Material Handling- Chowdary R B

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	Explain about the different types of material handling, advantages and disadvantages. It also suggests the selection procedure for the material handling along with its specifications.
CO2	Need for Material handling also explained with different techniques like Automated Material handling Design Program, Computerized material handling Planning will be dealt.
CO3	Demonstrate ability to successfully complete Fork Lift Certification to safely and effectively operate in the manufacturing environment.
CO4	The Material handling is explained with models, selection procedure of material handling is depending on different function oriented systems. This also related with plant layout by which the minimization of the handling charges will come down.
CO5	The ergonomics related to material handling equipment about design and miscellaneous equipment's.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1		1		1				1		1	1
CO2	1		1						1			
CO3		1	1	1		1					1	
CO4	1				1				1		1	
CO5		1			1				1		1	

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 **ACADEMIC YEAR: 2021-22**
SEMESTER : FIRST

COURSE TITLE : COMPOSITE MATERIALS & TECHONOLOGY		
Sub Code: 20MMD161	**No of Credits : L-T-P-SS**	**No. of lecture hours/week :04**

	3:0:0:0=4	
Exam Duration:3 hours	**CIE Marks:50**	**SEE Marks :50**

COURSE OBJECTIVES:

1. To study the basics of Composite materials.
2. To acquaint mechanics of lamina.
3. To study the micro and macro analysis of the lamina.
4. To gain knowledge of different techniques involved in production of composites.

#	CONTENTS	Hrs
UNIT-1	**INTRODUCTION TO COMPOSITE MATERIALS:** Definition, Classification, Types of matrices material and reinforcements, Characteristics &selection, Fiber composites, laminated composites, Particulate composites, Pre-pegs, and sandwich construction. **Metal Matrix Composites:** Reinforcement materials, Types, Characteristics and selection, Base metals, Selection, Applications	**11**
UNIT-2	**MACRO MECHANICS OF A LAMINA:** Hooke's law for different types of materials, Number of elastic constants, Derivation of nine independent constants for orthotropic material, Two - dimensional relationship of compliance and stiffness matrix. Hooke's law for two-dimensional angle lamina, engineering constants - Numerical problems. Invariant properties. Stress-Strain relations for lamina of arbitrary orientation, Numerical problems.	**11**
UNIT-3	**MICRO MECHANICAL ANALYSIS OF A LAMINA:** Introduction, Evaluation of the four elastic moduli, Rule of mixture, Numerical problems. Experimental Characterization of Lamina- Elastic Moduli and Strengths **Failure Criteria:** Failure criteria for an elementary composite layer or Ply, Maximum Stress and Strain Criteria, Approximate strength criteria, Inter-laminar Strength, Tsa-Hill theory, Tsai, Wu tensor theory, Numerical problem, practical recommendations	**10**
UNIT-4	**MACRO MECHANICAL ANALYSIS OF LAMINATE**: Introduction, code, Kirchoff hypothesis, Classical Lamination Theory, A, B, and D matrices (Detailed derivation), Special cases of laminates, Numerical problems. Shear Deformation Theory, A, B, D and E matrices (Detailed derivation) **Analysis of Composite Structures:** Optimization of Laminates, composite laminates of uniform strength, application of optimal composite structures, composite pressure vessels, spinning composite disks, composite lattice structures	**10**
UNIT-5	**MANUFACTURING AND TESTING:** Layup and curing - open and closed mould processing, Hand lay-up techniques, Bag moulding and filament winding. Pultrusion, Pulforming, Thermoforming, Injection moulding, Cutting, Machining, joining and repair. NDT tests – Purpose, Types of defects, NDT method - Ultrasonic inspection, Radiography, Acoustic emission and Acoustic ultrasonic method. **Applications:** Aircrafts, missiles, Space hardware, automobile, Electrical and Electronics, Marine, Recreational and sports equipment-future potential of composites.	**10**

TEXT BOOKS:

1. Autar K. Kaw, Mechanics of Composite materials, CRC Press, 2nd Ed, 2005.
2. Madhijit Mukhopadhay, Mechanics of Composite Materials & Structures, Universities Press, 2004.

REFERENCE BOOKS:

1. J. N. Reddy,Mechanics of Laminated Composite Plates & Shells, CRD Press, 2nd Ed, 2004.
2. Mein Schwartz, Composite Materials handbook, McGraw Hill, 1984.

3. Rober M. Jones,Mechanics of Composite Materials, Taylor & Francis, 1998.
4. Michael W,Hyer,Stress analysis of fiber Reinforced Composite Materials, Mc-Graw Hill International, 2009.

COURSE OUTCOME: At the completion of this course, students will be able to:

CO1	Identify the role of matrices and reinforcements used in practical composite structures.
CO2	Analyze problems on macro mechanical behavior of lamina.
CO3	Analyze problems on micro and assess the strength of laminated composite and predict its failure for given static loading conditions.
CO4	Understand various method involved in synthesis of composites and to optimize laminates.
CO5	Develop understanding of different methods of manufacturing and testing of composites

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1		1	1					1			
CO2		1		1	1						1	
CO3		1		1	1				1		1	
CO4	1		1		1						1	
CO5		1	1		1						1	

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 **ACADEMIC YEAR: 2021-22**
SEMESTER : FIRST

COURSE TITLE: TECHANICAL ACOUSTICS		
Sub Code: 20MMD162	**No of Credits : L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**SEE Marks :50**

COURSE OBJECTIVES:

1. To acquaint students the fundamentals of acoustics related to generation, transmission and control techniques.
2. To provide basic knowledge and understanding of noise and vibration control necessary for professional practice as a noise control engineer.
3. To expose them to acoustic instrumentation and techniques of sound measurement.
4. To understand Noise reduction and control techniques in Machinery, auditorium, and HVAC systems

#	CONTENTS	Hrs
UNIT-1	**Introduction to Acoustics:** Basics of acoustics - speed of sound, wavelength, frequency, and wave number, acoustic pressure and particle velocity, acoustic intensity and acoustic energy density, spherical wave, directivity factor and directivity index, levels and the decibel, combination of sound sources, octave bands, weighted sound levels.	**11**
UNIT-2	**Acoustics Evaluation Techniques:** Room Acoustics, Reverberation time, Acoustic materials, Absorption and Absorption Coefficient, Evaluation techniques. Sound and vibration analyzer (SVAN) Sound sources and Propagation – Plane and spherical waves, near and far field, free and reverberant field - Anechoic and Reverberant chambers.	**11**
UNIT-3	**Noise and physiological effects:** Noise and physiological effects , Acoustic criteria, the human ear, hearing loss, industrial noise criteria, speech interference level, noise criteria for interior spaces , Loudness, hearing, hearing loss, hearing protectors, Mechanism -Weighted Networks -Noise standards for traffic - Community noise -Aircraft - Environmental noise, Articulation index, and Machinery acoustics.	**10**
UNIT-4	**Acoustic Instrumentation:** Sound level and intensity meters - Octave analyzers, octave band filters, acoustic analysers, dosimeter, measurement of sound power, sound power measurement in a reverberant room, sound power measurement in an anechoic chamber, sound power survey measurements, measurement of the directivity factor, calibration, noise measurement procedures. **Sound power estimation** - Instruments for building acoustics -Speech Interference - Sound systems and Auditorium acoustics.	**10**
UNIT-5	**Noise control techniques:** At source and transmission path-Barriers and Enclosures- HVAC system noise, Machinery acoustics and levels- Near field monitoring and diagnostics - Active noise control techniques. Noise control in rooms, sound absorption.	**10**

TEXT BOOKS:

1. J.D. Irwin and E.R.Graf, (2001), Industrial Noise and Vibration control, Prentice Hall Inc.

REFERENCE BOOKS:

1. Bies and Colin. H. Hanson, (2001): Engg. Noise Control, E &FN SPON.
2. Noise Control Hand Book of Principles and Practices, David M.Lipsdomls Van Nostrand Reinhold Company.
3. Acoustic and Noise Control, (2000), B.J. Smith, R.J.Peters, Stephanie Owen.
4. Harris, C.K.–Handbook of Noise Control.
5. Petrusowicz and Longmore –Noise and Vibration control for industrialists.
6. Thumann and Miller- Secrets of Noise control.

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	Select appropriate noise control techniques for the solution of practical noise problems and evaluate their performance.
CO2	Understand how to use pressure wave expressions to describe sound transmission in different media.
CO3	Analyze complex noise environments and predict sound levels in desired locations.
CO4	Evaluate acoustic enclosures, barriers and walls for effective noise control.
CO5	Become familiar with sound measurement instrumentation.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1		1	1					1		1	
CO2		1		1			1		1			
CO3	1		1		1				1		1	
CO4		1		1	1						1	
CO5	1			1	1				1			

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 **ACADEMIC YEAR: 2021-22**
SEMESTER : FIRST

COURSE TITLE : DESIGN OPTIMIZATION		
Sub Code: 20MMD163	**No of Credits : L-T-P-SS 3:0:0:0=3**	**No. of lecture hours/week :04**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks :50**

Pre-requisites	Research Methodology, Composite Material, Basic Mathematics

COURSE OBJECTIVES:

1. To induce the students to the basics of Design optimization.
2. To acquaint Optimum Design Problem Formulation.
3. To analyze sensitivity analysis, Linear and Non Linear Approximations and Optimization Disciplines.
4. To explore and distinguish knowledge of different Manufacturability in Optimization Problems and Design Interpretation.

#	CONTENTS	Hrs
UNIT-1	**Engineering Design Practice:** Evolution of Design Technology, Introduction to Design and the Design Process, Design versus Analysis, Role of Computers in Design Cycle, Impact of CAE on Design, Numerical Modeling with FEA and Correlation with Physical Tests.	**11**
UNIT-2	**Optimum Design Problem Formulation**: Types of Optimization Problems, The Mathematics of Optimization, Design Variables and Design Constraints, Feasible and Infeasible Designs, Equality and Inequality Constraints, Discrete and Continuous Optimization, Linear and Non Linear Optimization. **Optimization Theory** – Fundamental Concepts, Global and Local Minimum, Gradient Vector and Hessian Matrix, Concept of Necessary and Sufficient Conditions, Constrained and Unconstrained Problems, Lagrange Multipliers and Kuhn Tucker Conditions	**11**
UNIT-3	**Sensitivity Analysis, Linear And Non Linear Approximations:** Gradient Based Optimization Methods – Dual and Direct. **Optimization Disciplines:** Conceptual Design Optimization and Design Fine Tuning, Combined Optimization, Optimization of Multiple Static and Dynamic Loads, Transient Simulations, Equivalent Static Load Methods	**10**
UNIT-4	**Manufacturability In Optimization Problems:** Design For Manufacturing, Manufacturing Methods and Rules, Applying Manufacturing Constraints to Optimization Problems. **Design Interpretation:** Unbound Problems, Over Constrained Problems, Problems with No of Multiple Solutions, Active and Inactive Constraints, Constraint Violations and Constraint Screening, Design Move Limits, Local and Global Optimum.	**10**
UNIT-5	**Dynamic Programming:** Introduction, Multistage decision processes, Principle of optimality, Computational Procedure in dynamic programming, Initial value problem, Examples. **Applications of Optimization in Engineering Design:** Automotive, Aerospace and General Industry Applications, Optimization of Metallic and Composite Structures, Minimization and Maximization Problems, MDO and MOO.	**10**

NOTE: the students are advised to prepare the report in the form of assignment to understand the subject and its relevance in the industry

TEXT BOOKS:

1. S.S.Rao, Engineering Optimization: Theory and Practice, John Wiley, 2009
2. JasbirArora, Introduction to Optimum Design, McGraw Hill, 2011.

REFERENCE BOOKS:

1. Optimisation and Probability in System Engg - Ram,Van Nostrand.
2. Optimization methods -K.V.Mital and C. Mohan,New age International Publishers, 1999.

3. Optimization methods for Engg. Design - R.L Fox, Addison – Wesley, 1971.

COURSE OUTCOME: At the completion of this course, students will be able to:

CO1	It provides the student with knowledge required to optimize an existing design with single or multiple objective functions.
CO2	Skills acquired through commercial optimization programs
CO3	Acquire the knowledge of engineering system design
CO4	Apply the concept of manufacturing constraint and design interpretation to optimization problems
CO5	Understand the concept of dynamic programming and apply the concept of optimization in engineering design

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1		1		1				1			
CO2		1	1		1				1		1	
CO3	1	1			1				1		1	
CO4		1			1				1		1	
CO5	1		1						1		1	

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 ACADEMIC YEAR: 2021-22
SEMESTER : FIRST

COURSE TITLE: PRODUCT DESIGN FOR QUALITY		
Sub Code: 20MMD164	**No of Credits : L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**SEE Marks :50**

COURSE OBJECTIVES:

1. Apply the principles of product design to modify existing engineering systems or to develop new artifacts.
2. Design a system taking into consideration the concepts of ease of production, maintenance, handling, installation etc.
3. Translate the concepts of economics in design, optimization of design and human factors approach to product design.

#	CONTENTS	Hrs
UNIT-1	**Design for quality**: Taguchi's Approach to Quality, On-line and Off-line Quality Control, Quality Loss Function, System Design, Parameter Design, Design for Environment, Human factor design, Design for casting and forging, Causes of Variation.	**11**
UNIT-2	**Quality Function Deployment –**Introduction, QFD team, benefits, voice of customer, organisation of information, house of quality, QFD process **Design of Experiments**: Basic methods- Two factorial experiments-Extended method reduced tests and fractional experiments, orthogonality, base design method, higher dimensional fractional factorial design	**11**
UNIT-3	**Failure Mode Effect Analysis:** Refining geometry and layout, Failure tree analysis, Defects and failure modes Techniques of failure analysis, Filed inspection of failure, Macroscopic and Microscopic examination, Additional tests, Analysis of data and report of failure.	**10**
UNIT-4	**Statistical Consideration in Product Design and Development** Frequency distributions and Histograms- Run charts –stem and leaf plots- Pareto diagrams-Cause and Effect diagrams-Box plots- Probability distribution- Statistical Process control–Scatter diagrams –Multivariable charts	**10**
UNIT-5	**Six Sigma** – Overview, Basics and history of the approach for six sigma, Methodology and focus, the application of Six Sigma in production and in-service industries, Relationship of Six Sigma and Lean Management, linking Six Sigma project goals with organizational strategy	**10**

REFERENCE BOOKS:

1. Total quality Management Kevin Otto & Kristin Wood, Product Design Techniques in Reverse
2. Engineering and New Product Development, Pearson Education (LPE), 2001. ISBN10: 0130212717
3. Product Design and Development, Karl T. Ulrich, Steven D. Eppinger, TATA McGraw - HILL - 3rd Edition, 2003. ISBN:13: 978-0073404776
4. The Management and control of Quality, James R. Evens, William M Lindsay,6th edition-South-Western Publishers ISBN: 0314062157
5. Engineering Design, George E Dieter, 3rd Edition, McGraw hill International Edition, ISBN: 0-07- 116204-6

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	Apply a system based approach for quality management
CO2	Identify the importance of various principles of quality in product or service
CO3	Use statistical tools in product development
CO4	Apply basic risk analysis and experiment design techniques into practical cases
CO5	Demonstrate knowledge about Six sigma, Design of Experiments

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1		1		1				1		1	
CO2	1	1		1					1			
CO3		1			1				1		1	
CO4	1		1						1		1	
CO5		1			1				1		1	

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 **ACADEMIC YEAR: 2021-22**
SEMESTER : FIRST

COURSE TITLE : COMPUTER AIDED ENGINEERING DEIGN WORK TOOL -LAB		
Sub Code: 20MMDL17	**No of Credits : L-T-P-SS 0:0:3:0 =2**	**No. of lecture hours/week :03**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**

COURSE OBJECTIVES:

1. The objective of this lab is to acquaintance students with knowledge in the interface of 3-D software and to make students efficient to produce CAED designs.
2. By the end of course one should also be able to understand what a machine drawing is and will also be able to produce machine drawings.
3. To gain knowledge about all symbols used in production drawings and how they are inserted in production drawings using design software's.

PART –A **COMPUTER AIDED ENGINEERING DESIGN- CAED BASICS**		Hours
1	Introduction about CAED and different workbenches in it.	4
2	Interface, Sketch Tools, View Tool bar, Profile Tool bar, Operation Tool bar, Tools , Constrain tool bar, Transformation Tool bar, User Selection Filter,.	4
3	Sketch Based Features, Dress up Features, Transformation Features, Reference Elements, Measure, Thickness, Boolean Operations.	4
4	Walls, Cutting and Stamping, Bending, Rolled Walls	4
5	Visualizations Surface, Operations	4
6	Wireframe, Replication. Standards Product Structure Tools, Constrains	4
PART –B **DESIGN AND DEVELOPMENT OF A PRODUCT USING CAD WORK TOOL**		Hours
1	Introduction to Geometric Dimensioning and Tolerance, Weld Symbols, GD&T Symbols, Types of Tolerances, Types of views, Roughness Symbols	4
2	Views, Annotations, Sheet Background.	4
3	Design of any two types of Aircraft structures	4
4	Design of fuselage with internal components	4
5	Design of Nose cone structures	4
6	Design of Main landing gear and nose landing gear	6

TEXT BOOKS:
1. 3D Modelling and practices , Engineering , Prof P. Krishnakumar
2. Introduction to CATIA V5 Release 19, Book by Kirstie Plantenberg
3. CATIA V5 Design Fundamentals Jaecheol Koh

REFERENCE BOOKS:
1. CATIA V5 Workbook Release 19, **Book by Richard Cozzens**

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	Understand the concepts and various tools used in design module.

CO2	Understand the design of typical structural components
CO3	Understand the techniques and standards of designing a component in CAD Software
CO4	Understand the design of three view diagram of a typical aircraft.
CO5	Analyze and evaluate CAD models

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1			1				1			
CO2		1		1	1				1		1	
CO3	1		1		1						1	
CO4	1		1		1				1			
CO5	1		1						1		1	

CONTINOUS INTERNAL EVALUATION (CIE)	
Evaluation of lab manual	30 Marks
Internal evaluation	10 Marks
Viva-voce	10 Marks
Total	50 Marks

SEMESTER END EXAMINATION (SEE)					
Sl. No.	**Particulars**	**Max. Marks**	**Break Up of Max. Marks**		
			Write Up	**MODELLING**	**ANALYSIS**
1	PART -A	**15**	05	05	05
2	PART-B	**25**	05	10	10
3	Viva Voce	**10**	--	--	--
TOTAL MARKS		**50**	**10**	**25**	**15**

- Two Full Questions to be set.
- Students shall be to be answered two full Questions.
- Each question(Experiments contains different Marks and it is clearly mentioned in the above table)
- Changing of Experiments is not allowed from any unit
- Viva Voce is compulsory

ADMISSION YEAR : 2021-22 **ACADEMIC YEAR: 2021-22**
SEMESTER : FIRST

COURSE TITLE: TECHANICAL SEMINAR		
Sub Code: 20MMDS18	**No of Credits : L-T-P-SS 0:0:2:0=02**	**No. of Lecture hours/week :**

Exam Duration: 3Hrs.	CIE Marks: 50	

COURSE OBJECTIVES:

1. Exposure of students to a variety of research projects and activities in order to enrich their academic experience.
2. An opportunity for students to develop skills in presentation and discussion of research topics in a public forum.
3. To identify good journals and journal papers; study the papers and understand, analyze, interpret and explain the contents of the paper.

GUIDELINES
1.Each student, under the guidance of a Faculty, is required to • Choose, preferably through peer reviewed journals, a recent topic of his/her interest relevant to the Course of Specialization. • Carryout literature survey, organize the Course topics in a systematic order. • Prepare the report with own sentences. • Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities. • Present the seminar topic orally and/or through power point slides. • Answer the queries and involve in debate/discussion. • Submit two copies of the typed report with a list of references. 2. All students should attend the seminars of other students of their specialization.
SCHEME FOR CONTINUOUS INTERNAL EVALUATION (CIE)
Each presentation shall be evaluated for 50 marks. Average marks obtained for three best presentations will be the student's CIE marks. **Marks distribution** Seminar Report: 20 marks Presentation skill:20 marks Question and Answer:10 marks

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	To identify good journals and journal papers
CO2	study the papers and understand, analyze, interpret and explain the contents of the paper

CO3	understand the shortcomings and plus points of published papers
CO4	To develop overall skills for technical communication and help technical decision making.
CO5	To understand the latest research in their field of study

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1			1					1		1	
CO2	1		1						1			
CO3	1			1					1		1	
CO4		1		1	1				1			
CO5	1			1					1			1
High-3 Medium-2 Low-1												

ADMISSION YEAR : 2021-22 ACADEMIC YEAR: 2021-22
SEMESTER : FIRST

COURSE TITLE: INDUSTRY VISIT

Sub Code: 20MMDM19	No of Credits : L-T-P-SS 0:0:0:2=02	No. of Lecture hours/week : --------
	CIE Marks: 50	

COURSE OBJECTIVES:

1. An opportunity to get exposure to the real workstations, plants, machines and systems.
2. to understand the end-to-end process at all levels
3. to understand the company policies in terms of production, quality, and service management.
4. Expert briefing about the functioning of machines and systems.

GUIDELINES

1. Iindustrial visit shall be arranged according to the academic requirements and as per the norms of the college.
2. HOD must certify that the tour is required for the students or is related to their curriculum.
3. The visiting companies shall be relevant and suitable ones to the specialization and academic requirements.
4. Industrial visit shall fall within the stipulated period set by the college.
5. The stipulated period shall be informed to the Faculty in-charge and Students through HOD well in advance to enable go through a diligent process including communicating to the potential companies and obtaining permission to visit.
6. The entire plan including permission letter from the visiting companies, permission letter, route map, list of students with their contact no. (Preferably mobile phone), list of faculty with their contact details, undertaking letter from student and parent and permit shall be available in the file and be checked by HOD.
7. The bus shall carry a banner exhibiting the college name and Industrial Visit.
8. Students must carry security ID cards with details of their parents or local guardians and their contact numbers.
9. Participating students must be given an undertaking that they will abide by the rules and guidelines throughout the tour.

SCHEME FOR CONTINUOUS INTERNAL EVALUATION (CIE)

CIE marks for the Industrial visit report (30 marks), seminar (10 marks) and viva voce (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department, The committee shall consist of three faculty from the department.

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	Students' exposure to industrial environments and experiences is undeniably one way for students to appreciate their theoretical learning to a more practical learning.
CO2	Acquaint Students with Interesting Facts and Newer Technologies.
CO3	Using the case study approach within the visit brings out critical thinking among students.
CO4	Practical application of instruments handled during course curriculum.
CO5	Students Aware with Industry Practices.

MAPPING OF COs WITH POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1		1				1		1		1	1
CO2		1	1		1				1			
CO3	1		1		1				1		1	
CO4		1	1		1		1				1	
CO5	1		1		1						1	
High-3 Medium-2 Low-1												

ADMISSION YEAR : 2021-22 ACADEMIC YEAR: 2021-22
SEMESTER : SECOND

COURSE TITLE:ADVANCED THEORY OF VIBRATIONS

Sub Code: 20MMD21	No of Credits : L-T-P-SS 3:0:0:0=3	No. of Lecture hours/week :04
Exam Duration:3 hours	**CIE Marks: 50**	**SEE Marks: 50**

COURSE OBJECTIVES:

1. To acquainting the learners the importance of vibrations in design of machine parts subject to vibrations.
2. To explore the concepts of transient and Non-linear vibrations.
3. To acquire the skill of vibration measurements and its applications.
4. To evaluate the results of Transient and Nonlinear vibrations.

#	CONTENTS	Hrs
UNIT-1	**Review of Mechanical Vibrations:** Basic concepts; free vibration of single degree of freedom systems with and without damping, forced vibration of single DOF-systems, Natural frequency. Transient Vibration of single Degree-of freedom systems: Impulse excitation, Arbitrary excitation.	**11**
UNIT-2	**Vibration Control:** Introduction, Vibration isolation theory, Vibration isolation and motion isolation for harmonic excitation, practical aspects of vibration analysis, shock isolation, Dynamic vibration absorbers, and Vibration dampers. Vibration Measurement and applications: Introduction, Transducers, Vibration pickups, Frequency measuring instruments, Vibration exciters, Signal analysis.	**11**
UNIT-3	**Modal analysis:** Dynamic Testing of machines and Structures, Experimental Modal analysis. **Vibrations of beams:** equation of motion, modal analysis, approximate methods, initial value problem, forced vibrations, special problems, wave propagation Vibrations of membranes: equations of motion, modal analysis, and approximate methods. **Vibrations of plates:** equations of motion, modal analysis, approximate methods.	**10**
UNIT-4	**Random Vibrations :** Random phenomena, Time averaging and expected value, Frequency response function, Probability distribution, Correlation, Power spectrum and power spectral density, Fourier transforms, FTs and response.	**10**
UNIT-5	**Signature analysis** and preventive maintenance, Vibration testing equipment, signal generation, measuring and conditioning instruments. **Vibration testing equipment:** Signal analysis instruments, Vibration signatures and standards.	**10**

TEXT BOOKS:

1. S. S. Rao, " Mechanical Vibrations" , Pearson Education,4TH Edition.
2. S. Graham Kelly," Fundamentals of Mechanical Vibration" -McGraw-Hill, 2000 .

REFERENCES BOOKS:

1. Mechanical Vibrations, S. Graham Kelly, Schaum's Outlines, Tata McGraw Hill, 2007.ISBN-10:
2. 1439062129
3. Theory of Vibration with Application, William T. Thomson, Marie Dillon Dahleh, Prentice Hall
4. Edition, ISBN, 0748743804, 2011
5. Vibrations & Acoustics, Sujatha, Tata McGraw Hill Edition, ISBN: 9780070148789, 2013
6. Mechanical Vibrations, S.S.Rao, Pearson Education, 4th ed., ISBN 978-0-13-212819-3, 2012

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	Construct Equations of motion based on free body diagrams
CO2	Analyse systems under free and forced vibrations for natural frequency of vibration.
CO3	Evaluate Mechanical Systems are using modal analysis.
CO4	Develop solutions through testing for vibrations and signature analysis techniques.
CO5	Apply the fundamentals of vibration to its measurement and Analysis.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1									1		1
CO2		1			1				1		1	
CO3	1		1									
CO4	1			1						1		1
CO5		1				1					1	1
High-3 Medium-2 Low-1												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 ACADEMIC YEAR: 2021-22
SEMESTER : SECOND

COURSE TITLE:DESIGN FOR FATIGUE LOADING		
Sub Code: 20MMD22	**No of Credits : L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**SEE Marks: 50**

COURSE OBJECTIVES:

1. To identify failure modes and evolve design by analysis methodology.
2. To understand the concept of fatigue testing of materials including criteria for fatigue design and different fatigue life models.
3. To understand the concept of crack nucleation, crack growth and fracture of materials using fundamentals of linear elastic fracture mechanics.
4. To understand the different surface failure mechanisms with stress distribution of various contact surfaces.

#	CONTENTS	Hrs
UNIT-1	**Introduction:** Role of failure prevention analysis in mechanical design, Modes of mechanical failure, Review of failure theories for ductile and brittle materials including Mohr's theory and modified Mohr's theory, Numerical examples. Fatigue of Materials: Introductory concepts, High cycle and low cycle fatigue, Fatigue design models, Fatigue design methods ,Fatigue design criteria, Fatigue testing, Test methods and standard test specimens, Fatigue fracture surfaces and macroscopic features, Fatigue mechanisms and microscopic features	**11**
UNIT-2	**Stress-Life (S-N) Approach:** S-N curves, the statistical nature of fatigue test data, General S-N behaviour, Mean stress effects, Different factors influencing S-N behaviour, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using SN approach. Strain-Life(ε- N)approach: Monotonic stress-strain behaviour ,Strain controlled test methods, Cyclic stress-strain behaviour, Strain based approach to life estimation, Determination of strain life fatigue properties,Mean stress effects, Effect of surface finish, Life estimation by ε-N approach.	**11**
UNIT-3	**LEFM Approach**: LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress effects, Crack growth life estimation. Notches and their effects: Concentrations and gradients in stress and strain, S-N approach for notched membranes, mean 30 stress effects and Haigh diagrams, Notch strain analysis and the strain – life approach, Neuber's rule, Glinka's rule, and applications of fracture mechanics to crack growth at notches.	**10**
UNIT-4	**Fatigue from Variable Amplitude Loading:** Spectrum loads and cumulative damage, Damage quantification and the concepts of damage fraction and accumulation, Cumulative damage theories, Load interaction and sequence effects, Cycle counting methods, Life estimation using stress life approach.	**10**
UNIT-5	**Surface Failure:** Introduction, Surface geometry, Mating surface, Friction, Adhesive wear, Abrasive wear, Corrosive wear, Surface fatigue spherical contact, Cylindrical contact, General contact, Dynamic contact stresses, Surface fatigue strength.	**10**

TEXT BOOKS:

1. RalphI. Stephens,Ali Fatemi, Robert, Henryo. Fuchs, “MetalFatiguein engineering” , John WileyNew York, Second edition. 2001.
2. FailureofMaterials in Mechanical Design, Jack.A. Collins,John Wiley,New York 1992.
3. RobertL.Norton , “ Machine Design” , Pearson EducationIndia, 2000.

REFERENCES BOOKS:

1. Metal Fatigue in engineering, Ralph I. Stephens, Ali Fatemi, Robert, Henry o. Fuchs, John wiley Newyork, Second edition. 2001. ISBN: 978-1-933489-67-4
2. Failure of Materials in Mechanical Design, Jack. A. Collins, John Wiley, Newyork 1992. ISBN: 988-3-955783-62-2
3. Machine Design, Robert L. Norton, Pearson Education India, 2000, ISBN 0-06-00849-3
4. Fatigue of Materials, S.Suresh, Cambridge University Press, -1998

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	Distinguish different design criteria and their procedure to carry out the design of mechanical components.
CO2	Design machine components which are subjected to fluctuating loads.
CO3	Design machine components using techniques like stress life approach, Strain life approach and Fracture mechanics approach.
CO4	Define the various statistical aspects of fatigue using different probability distribution plots.
CO5	Explain the contact stresses and implementation of Hertz contact phenomenon to the real field problem.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1		1						1		1	
CO2	1	1		1		1				1		
CO3		1	1		1				1		1	
CO4	1			1	1					1	1	
CO5		1	1		1					1	1	
High-3 Medium-2 Low-1												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 **ACADEMIC YEAR: 2021-22**
SEMESTER : SECOND

COURSE TITLE: TRIBOLOGY & BEARING TECHONOLOGY		
Sub Code: 20MMD23	**No of Credits : L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**SEE MARKS:50**

COURSE OBJECTIVES:

1. To understand the fundamental principles of lubrication for reduction of friction and wear.
2. To understand the principles of hydrodynamic and hydrostatic lubrication and their design and applications.
3. To learn the computations required for selecting and designing bearings in machines.
4. To understand the factors influencing the design and selection of Porous and Magnetic bearings.

#	CONTENTS	Hrs
UNIT-1	**Introduction to Tribology:** Introduction, Friction, Wear, Wear Characterization, Regimes of lubrication, Classification of contacts, lubrication theories, Effect of pressure and temperature on viscosity. Newton's Law of viscous forces, Flow through stationary parallel plates. Hagen's poiseuille's theory, viscometers. Numerical problems, Concept of lightly loaded bearings, Petroff's equation, Numerical problems	**11**
UNIT-2	**Hydrodynamic Lubrications:** Pressure development mechanism. Converging and diverging films and pressure induced flow. Reynolds's 2D equation with assumptions. Introduction to idealized slide bearing with fixed shoe and Pivoted shoes. Expression for load carrying capacity. Location of center of pressure, effect of end leakage on performance, Numerical problems. **Journal Bearings:** Introduction to idealized full journal bearings. Load carrying capacity of idealized full journal bearings, Somerfield number and its significance, partial bearings, Comparison between lightly loaded and heavily loaded bearings, effects of end leakage on performance, Numerical problems.	**11**
UNIT-3	**Hydrostatic Bearings:** Hydrostatic thrust bearings, hydrostatic circular pad, annular pad, rectangular pad bearings, expression for discharge, load carrying capacity and condition for minimum power loss, numerical problems **Antifriction bearings:** Advantages, selection, nominal life, static and dynamic load bearing capacity, probability of survival, equivalent load, cubic mean load, bearing mountings.	**10**
UNIT-4	**EHL Contacts:** Introduction to Elasto - hydrodynamic lubricated bearings. Introduction to 'EHL' constant. Grubin type solution. **Porous Bearings:** Introduction to porous and gas lubricated bearings. Governing differential equation for gas lubricated bearings, Equations for porous bearings and working principal, Fretting phenomenon and its stages.	**10**
UNIT-5	**Magnetic Bearings:** Introduction to magnetic bearings, Active magnetic bearings. Different equations used in magnetic bearings and working principal. Advantages and disadvantages of magnetic bearings,,Electrical analogy, Magneto-hydrodynamic bearings.	**10**

TEXT BOOKS:

1. Mujamdar.B.C "Introduction to Tribology of Bearing", Wheeler Publishing, New Delhi 2001
2. Radzimovsky, "Lubrication of Bearings - Theoretical principles and design" Oxford press organization 2000.

REFERENCES BOOKS:

1. Theory and practice of Lubrication for Engineers, Dudley D.Fuller, New YorkCompany.1998
2. Principles and applications of Tribology, Moore, Pergamon press, 1975
3. Engineering Tribology, G W Stachowiak, A W Batchelor, Elsevier publication 1993.
4. Lubrication of Bearings - Theoretical principles and design, Radzimovsky, Oxford press Company, 2000.

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	Demonstrate fundamentals of tribology, lubricants and methods of lubrication
CO2	Analyze bearings for load carrying capacity, frictional force and power loss.
CO3	Illustrate the different modes of lubrication system for various applications.
CO4	Design the different bearing system such as antifriction bearings for various applications
CO5	Explain the concepts advanced bearings like magnetic bearings, porous bearings and gas lubricated bearings.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1		1			1			1		1	
CO2		1		1	1		1	1		1	1	
CO3	1		1	1					1		1	
CO4			1	1			1		1		1	
CO5												
High-3 Medium-2 Low-1												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 **ACADEMIC YEAR: 2021-22**

SEMESTER : SECOND

COURSE TITLE:FRACTURE MECHANICS		
Sub Code: 20MMD24	**No of Credits : L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**SEE MARKS:50**

COURSE OBJECTIVES:

1. To understand the design principle of materials and structures using fracture mechanics approaches.
2. To introduce the mathematical and physical principles of fracture mechanics and their applications to engineering design.
3. To develop the ability in students to compute the stress intensity factor, strain energy release rate and the stress and strain fields around a crack tip for linear and non linear materials.
4. To prepare the students for broader applications of fracture mechanics in material testing, evaluation, characterization, and material selection.

#	CONTENTS	Hrs
UNIT-1	**Fracture Mechanics Principles:** Introduction and historical review, sources of micro and macro cracks, stress concentration due to elliptical hole, strength ideal materials, Griffith's energy balance approach. Fracture mechanics approach to design. NDT and Various NDT methods used in fracture mechanics, numerical problems. The Airy stress function, complex stress function, solution to crack problems, effect of finite size, special cases, elliptical cracks, numerical problems.	**11**
UNIT-2	Plasticity effects, Irwin plastic zone correction, and Dugdale approach. The shape of the plastic zone for plane stress and plane strain cases, plastic constraint factor. The thickness effect, and numerical problems. **Determination of stress intensity factors and plane strain fracture toughness**: Introduction, analysis and numerical methods, experimental methods, estimation of stress intensity factors. **Plane strain fracture toughness test;** standard test, and specimen size requirements.	**11**
UNIT-3	The energy release rate, and criteria for crack growth. The crack resistance (R curve), compliance, J integral, tearing modulus and stability. **Elastic Plastic Fracture Mechanics (EPFM)**: Fracture beyond general yield. The crack-tip opening displacement, the use of CTOD criteria, and experimental determination of CTOD. Parameters affecting the critical CTOD, use of J integral, and limitation of J integral.	**10**
UNIT-4	**Dynamics and crack arrest:** Crack speed and kinetic energy. Dynamic stress intensity and elastic energy release rate. Crack branching. Principles of crack arrest. Crack arrest in practice. Dynamic fracture toughness.	**10**
UNIT-5	**Fatigue crack propagation and applications of fracture mechanics:** Crack growth and the stress intensity factor. Factors affecting crack propagation. Variable amplitude service loading, means to provide fail-safety, required information for fracture mechanics approach, mixed mode (combined) loading and design criteria.	**10**

TEXT BOOKS:

1. David Broek, “Elementary Engineering Fracture Mechanics”, Springer Netherlands,2011
2. Anderson , “Fracture Mechanics-Fundamental and Application”, T.L CRC press1998.

REFERENCES BOOKS:

5. Karen Hellan , “Introduction to fracture mechanics”, McGraw Hill, 2nd Edition.
6. S.A. Meguid , “Engineering fracture mechanics” Elsevier Applied Science, 1989.
7. Jayatilaka, “Fracture of Engineering Brittle Materials”, Applied Science Publishers, 1979.
8. Rolfe and Barsom , “Fracture and Fatigue Control in Structures” , Prentice Hall, 1977.
9. Knott , “Fundamentals of fracture mechanisms”, Butterworths, 1973.

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	Develop basic fundamental understanding of the effects of crack like defects on the performance of aerospace, civil, and mechanical engineering structures.
CO2	Be able to select appropriate materials for engineering structures to insure damage tolerance.
CO3	Learn to employ modern numerical methods to determine critical crack sizes and fatigue crack propagation rates in engineering structures.
CO4	Understanding of experimental techniques to determine the critical values of parameters at crack tip.
CO5	Understand and appreciate of the status of academic research in field of fracture mechanics.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1		1					1		1	
CO2	1		1	1		1			1		1	
CO3	1		1	1	1				1		1	
CO4		1	1	1		1					1	
CO5	1	1		1	1						1	
High-3 Medium-2 Low-1												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 **ACADEMIC YEAR: 2021-22**
SEMESTER : SECOND

COURSE TITLE:ADVANCED SYSTEM DESIGN		
Sub Code: 20MMD251	**No of Credits : L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**SEE MARKS:50**

COURSE OBJECTIVES:

1. To understand the design principle of materials and structures using fracture mechanics approaches.
2. To introduce the mathematical and physical principles of fracture mechanics and their applications to engineering design.
3. To develop the ability in students to compute the stress intensity factor, strain energy release rate and the stress and strain fields around a crack tip for linear and nonlinear materials.
4. To prepare the students for broader applications of fracture mechanics in material testing, evaluation, characterization, and material selection.

#	CONTENTS	Hrs
UNIT-1	**INTRODUCTION**: What is designing, Man as a designer: Design by evolution, inadequacies of traditional design method: System approach of engineering problems: Need models: design history of large scale existing system. Morphology of Design: The three phases of design projects, the structure of design process, decision making and iteration.	**10**
UNIT-2	**IDENTIFICATION, NEED ANALYSIS &DESIGN CONCEPT:** Preliminary need statement, analysis of need, specifications, and standards of performance and constraints. Process of idealization, mental fixity, analysis, AIDA, brain storming etc.	**10**
UNIT-3	**PRELIMINARY DESIGN:** Mathematical modeling for functional design: concept of sensitivity, compatibility and stability analysis. Evaluation Of Alternatives And Design Decisions.	**10**
UNIT-4	**DESIGN TREE:** Quality of design, Concept of utility, multi criteria decisions, decisions under uncertainty and risk (Numerical), Bath tub curve, exponential reliability function, system reliability concept. (Numerical)	**10**
UNIT-5	**ECONOMICS AND OPTIMIZATION IN ENGINEERING DESIGN**: Economics in Engineering Design, Fixed and variable costs, break-even analysis. (Numerical) Optimization: Introduction to LPP. Man Machine Interaction, Designing for use and maintenance, Man-Machine Cycle, Design of displays and controls. Factors influencing displays and controls.	**12**

REFERENCES BOOKS:

1. Mechanical System Design by: W. E. Ederlecturer In Mechanical Engineering And'w. Gosling

2. Harrison Kim,Dept. of Industrial and Enterprise Systems Engineering (ISE) - 2 - 1. Papalambros, P.Y. and Wilde, D., Principles of Optimal Design (2nd Ed.), Cambridge University Press, New York, 2000. 2.

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	Analyze the types of design and concepts
CO2	Applying the concept of need based design.
CO3	Implement preliminary design concept in real life.
CO4	Analyzing the process of design in the form of sequence of actions.
CO5	Implement economics during engineering Design and study Man-Machine Cycle.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1		1	1		1			1	1		
CO2	1	1	1			1			1		1	
CO3	1		1	1								1
CO4		1		1			1					
CO5	1				1	1		1		1		
High-3 Medium-2 Low-1												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 **ACADEMIC YEAR: 2021-22**
SEMESTER : SECOND

COURSE TITLE:AUTOMOBILE SYSTEM DESIGN		
Sub Code: 20MMD252	**No of Credits : L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**SEE MARKS:50**

COURSE OBJECTIVES:

1. To understand of the stages involved in automobile system design.
2. To expose the industrial practices in design of various systems of automobile.
3. To study importance and features of different systems like axle, differential, brakes, Steering, suspension, and balancing etc.
4. To study working of various Automobile Systems.

#	CONTENTS	Hrs
UNIT-1	**Body Shapes**: Aerodynamic Shapes, drag forces for small family cars. **Fuel Injection**: Spray formation, direct injection for single cylinder engines (both SI & CI), energy audit.	**10**
UNIT-2	**Design of I.C. Engine I:** Combustion fundamentals, combustion chamber design, cylinder head design for both SI & C. I. Engines.	**10**
UNIT-3	**Design of I.C. Engine II:** Design of crankshaft, camshaft, connecting rod, piston & piston rings for small family cars (max up to 3 cylinders).	**10**
UNIT-4	**Transmission System:** Design of transmission systems – gearbox (max of 4-speeds), differential. **Suspension System**: Vibration fundamentals, vibration analysis (single & two degree of freedom, vibration due to engine unbalance, application to vehicle suspension.	**10**
UNIT-5	**Cooling System**: Heat exchangers, application to design of cooling system (water cooled). **Emission Control**: Common emission control systems, measurement of missions, exhaust gas emission testing.	**12**

REFERENCES BOOKS:

1. **Mechanical System Design** by: W. E. Ederlecturer in Mechanical Engineering And'w. Gosling
2. Harrison Kim,Dept. of Industrial and Enterprise Systems Engineering (ISE) - 2 - 1. Papalambros, P.Y. and Wilde, D., **Principles of Optimal Design** (2nd Ed.), Cambridge University Press, New York, 2000. 2.

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	Gain an insight into aspects of vehicle design, operation and maintenance, which will be useful for taking up a position in the automotive industry.
CO2	Apply the knowledge in creating a preliminary design of Automobile sub systems.
CO3	Identify construction, working, preventive maintenance, trouble shooting and diagnosis of various Automobile Systems.
CO4	Identify Modern technology and safety measures used in Automotive Vehicles.
CO5	Analyse the cooling and Emission control in automotive vehicles.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1		1		1	1			1		1	
CO2		1		1		1				1	1	
CO3	1			1	1				1		1	
CO4	1		1		1				1		1	
CO5		1		1					1		1	
High-3 Medium-2 Low-1												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 **ACADEMIC YEAR: 2021-22**
SEMESTER : SECOND

COURSE TITLE: DESIGN OF HYDRAULIC & PNEUMATIC SYSTEMS		
Sub Code: 20MMD253	**No of Credits : L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**SEE MARKS:50**

COURSE OBJECTIVES:

1. To understand of the stages involved in Hydraulic & Pneumatic design.
2. To expose the maintenance practices in various systems of hydraulics.
3. To study and analyze the hydraulic circuit design.
4. To study working of Pneumatic Systems.

#	CONTENTS	Hrs
UNIT-1	**Introduction to Hydraulic System**: Introduction, Basic hydraulic system, classification of hydraulic motors, hydraulic pumps, Performance of hydraulic motors, Hydraulic actuators, types of hydraulic actuators. **Control Components in Hydraulic Systems:** Introduction, Direction control valves, Solenoid actuated valve, Pilot operated valve, Rotary spool DCV, Pressure control valves, Hydraulic fuse, Flow control valve, graphic symbols.	**10**
UNIT-2	**Maintenance of Hydraulic Systems:** Prime function of hydraulic fluids, desirable properties of hydraulic fluids, general types of fluids, factors affecting the selection of fluids, sealing devices, reservoir systems, filters and strainers, heat exchangers, pressure switch, wear of moving parts, troubleshooting of hydraulic systems. Maintainance of Pumps	**10**
UNIT-3	**Hydraulic circuit Design and Analysis:** Control of a single acting cylinder, double acting cylinder, regenerative circuit, counter balance valve applications, Hydraulic cylinder sequencing circuits, automatic cylinder reciprocating systems, Locked cylinder using pilot check valves, cylinder synchronizing circuits, fail safe circuits..	**10**
UNIT-4	**Pneumatic Concepts:** Introduction, comparison of hydraulics/pneumatics/and electrical system, air compressor system, types of compressors, compressed air behavior, pneumatic actuators, direction control valves, building a pneumatic circuits, application of logic valves. **Design of Pneumatic Circuits:** Speed control circuits, Application of time delay valves. Position sensing in pneumatic cylinders, roller lever valve, pressure sensing in pneumatic circuits, pressure sequence valve, two cylinder movement, cascade method.	**10**
UNIT-5	**Electro-Pneumatics:** Introduction, Pilot operated solenoid valve, Electrical connection to the solenoid, Electro-pneumatic circuit, Electrical limit switches and proximity switches, Relays, Solenoid, PE converter, Concept of latching. **Servo System and PLC Applications in Pneumatics**: Closed loop control with servo system, Hydro- mechanical servo system, Electro-hydraulic servo system, Conventional valve vs proportional valve, Proportional valve in hydraulic circuits, characteristics of proportional valve and servo valve. PLC application in fluid power, logic in ladder logic diagram and Mnemonics, Timer- on delay and of delay.	**12**

REFERENCES BOOKS:

1. Introduction to Hydraulics and Pneumatics, S Ilango, V Soundararajan, PHI Publication, ISBN-978-
2. 81-203-3079-5.
3. Hydraulics and Pneumatics, Jagadeesha T, I K International Publication, ISBN: 978-93-84588-90-8
4. Introduction to fluid power, James L Johnson, Cengage Learning, First Edition 2003, ISBN- 981- 243-661-8
5. Hydraulic and pneumatic controls, R Srinivasan, Tata McGraw hill, second edition,2010 ISBN – 978-81-8209-138-2.

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	Describe the constructional features of hydraulic and pneumatic components.
CO2	Apply hydraulic and pneumatic controls in the design of automated controls.
CO3	Evaluate the design of hydraulic and pneumatic components for building a circuit.
CO4	Design the hydraulic and pneumatic based systems for industrial applications.
CO5	Analyze the PLC applications in Pneumatics.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1		1			1			1		1	
CO2	1	1		1					1			1
CO3	1		1		1	1					1	
CO4		1	1	1			1				1	
CO5	1	1		1	1						1	
High-3 Medium-2 Low-1												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

SEMESTER : SECOND

COURSE TITLE: ADVANCED FINITE ELEMENT ANALYSIS		
Sub Code: 20MMD254	**No of Credits : L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**SEE MARKS:50**

COURSE OBJECTIVES:

1. To understand of the stages involved in Hydraulic & Pneumatic design.
2. To expose the maintenance practices in various systems of hydraulics.
3. To study and analyze the hydraulic circuit design.
4. To study working of Pneumatic Systems.

#	CONTENTS	Hrs
UNIT-1	**Basics of Finite Element Analysis**: Shape function of the linear bar element, quadratic bar element, 2-D Constant strain triangular element, 2-D linear triangular element, 4 noded quadrilateral element, 9- noded quadrilateral element and scrindipidy elements. Stiffness, traction and body force equations for1-D 2 noded element, 2-D truss element, CST element and 4 noded quadrilateral elements and related problems.	11
UNIT-2	**Axisymmetric Solids**: Structures of Revolution, Axisymmetric Solid Iso-P Elements,Iso-P Quadrilateral Ring Elements, Benchmark Problems.A Complete Axisymmetric FEM Program. Axisymmetric Solid.	11
UNIT-3	**General Solids**: Solid Elements: Overview. The Linear Tetrahedron, The Quadratic Tetrahedron.The 8-Node Hexahedron. The 20-Node Hexahedron. Pyramid solid elements: a successful application of morphing.	10
UNIT-4	**Dynamic Analysis using Finite Element Method**: Introduction – vibrational problems – equations of motion based on weak form – longitudinal vibration of bars – transverse vibration of beams – consistent mass matrices – element equations –solution of eigenvalue problems – vector iteration methods – normal modes – transient vibrations – modeling of damping – mode superposition technique – direct integration methods.	10
UNIT-5	**Applications in Heat Transfer & Fluid Mechanics**: One dimensional heat transfer element –application to one-dimensional heat transfer problems- scalar variable problems in 2-Dimensions– Applications to heat transfer in 2- Dimension – Application to problems in fluid mechanics in 2-D	10

REFERENCES BOOKS:

1. Introduction to Finite Elements in Engineering, Chandrupatla T. R., and Belegundu, A.D., Prentice
2. Hall, 2003.
3. An Introduction to the Finite Element Method, Reddy, J. N. 3rd Edition, McGraw-Hill
4. Science/Engineering/Math, 2005.
5. The Finite Element Method in Engineering, S. S. Rao, Fifth Edition, Elsevier Publications.
6. Advanced Finite Element Methods and Applicatons, Thomas Apel and Olaf Steinbach, Springer
7. Publications, ISBN 978–3–642–30315–9, 2013

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	Explain the fundamentals of finite element methods
CO2	Develop the knowledge to analyses, structures under static and dynamic conditions.
CO3	Selection of numerical techniques for solving engineering problems
CO4	Explore the use of finite element method knowledge to implement industrial project.
CO5	Analyze the applications of Finite Element Analysis in Heat transfer.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1		1					1		1	
CO2		1	1		1				1		1	
CO3	1		1		1						1	
CO4	1		1	1		1			1			
CO5	1		1			1					1	
High-3 Medium-2 Low-1												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 **ACADEMIC YEAR: 2021-22**

SEMESTER : SECOND

COURSE TITLE: PRESSURE VESSEL DESIGN		
Sub Code: 20MMD261	**No of Credits : L-T-P-SS**	**No. of Lecture hours/week :04**

	3:0:0:0=3	
Exam Duration:3 hours	**CIE Marks: 50**	**SEE Marks: 50**

COURSE OBJECTIVES:

1. Apply the principles of product design to modify existing engineering systems or to develop new artifacts.
2. Design a system taking into consideration the concepts of ease of production, maintenance, handling, installation etc.
3. Translate the concepts of economics in design, optimization of design and human factors approach to product design.

#	CONTENTS	Hrs
UNIT-1	**General Introduction:** Review of equations of elasticity- kinematics, compatibility equations, stress measures- equations of motions- constitutive relations- transformation of stresses, strains and stiffness- energy principles and variational methods in elasticity- virtual work- external and internal virtual work variational operator- functionals- Euler Lagrange equations- energy principles- Hamilton's principle- principle of minimum total potential- applications.	**11**
UNIT-2	**Classical Theory Of Plates:** Plates as structural elements- stress and moment resultants- assumptions made in the classical theory- displacement fields and strains- equations of equilibrium in Cartesian coordinates and in polar coordinates- boundary conditions – bending of rectangular plates with various boundary conditions and loading- symmetrical and asymmetrical bending of circular plates-limitations of classical theory- finite element analysis	**11**
UNIT-3	**Buckling Analysis of Rectangular Plates:** Buckling of simply supported plates under compressive forces- governing equations- the Navier solution- biaxial compression of a plate- uniaxial compression of a plate- buckling of plates simply supported on two opposite edges- Levy's solution- buckling of plates with various boundary conditions- general formulation- finite element analysis	**10**
UNIT-4	**Vibration of Plates:** Governing equations for natural flexural vibrations of rectangular plates- natural vibrations of plates simply supported on all edges- vibration of plates with two parallel sides simply supported Levy's solution- vibration of plates with different boundary conditions- Rayleigh-Ritz method Natural vibration of plates with general boundary conditions- transient analysis of rectangular plates- finite element analysis.	**10**
UNIT-5	**Analysis of Thin Elastic Shells of Revolution:** Classification of shell surfaces- geometric properties of shells of revolution- general strain displacement relations for shells of revolution- stress resultants- equations of motion of thin shells, analytical solution for thin cylindrical shells- membrane theory- flexure under axisymmetric loads, shells with double curvature- geometric considerations- equations of equilibrium- bending of spherical shells- vibration of cylindrical shells- finite element analysis.	**10**

REFERENCE BOOKS:

1. Theory and Analysis of Elastic Plates & Shells, Reddy,J.N., C.R.C. Press, NY, USA, 2nd Edition, ISBN 9780849384158

2. Theory and Analysis of Plates, Szilard, R., Prentice Hall Inc., 1999,ISBN 0-12-9353336-2

3. Theory of Plates and Shells, Timoshenko, S. and Krieger S.W, McGraw Hill Book Company, New York 1990, ISBN 0-13-913426-3
4. Stresses in shells, Wilhelm Flügge, Springer –Verlag, *ISBN* 978-3-662-01028-0.

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	Review the equations of elasticity.
CO2	Apply the structural mechanics approximations of membrane, plates and shells.
CO3	Develop simple modifications to the membrane plate and shell theories.
CO4	Describe the static, dynamic, and non-linear motion of membrane, plate and shell structures.
CO5	Analyze numerical problems in shells of revolution.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1		1		1				1			
CO2		1	1		1				1		1	
CO3	1		1	1					1			
CO4	1	1		1							1	
CO5	1		1		1				1		1	

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR: 2021-22 **ACADEMIC YEAR: 2021-22**
SEMESTER : SECOND

COURSE TITLE: DESIGN FOR MANUFACTURE AND ASSEMBLY		
Sub Code: 20MMD262	**No of Credits : L-T-P-SS**	**No. of Lecture hours/week :04**

	3:0:0:0=3	
Exam Duration:3 hours	**CIE Marks: 50**	**SEE Marks: 50**

COURSE OBJECTIVES:

1. To understand various general design rules for manufacturability and criteria for material selection
2. To study various machining process and tolerance aspects in machining.
3. To know the design considerations for casting, forging and welding process.
4. To study the general design guidelines for manual assembly and development of DFMA Methodology.

#	CONTENTS	Hrs
UNIT-1	**Introduction to Design for Manufacture & Assembly:** Steps in DFMA, Advantages of DFMA, Design guidelines for Manual Assembly and High-Speed Automatic and Robotic Assembly. **Geometrical Dimensioning & Tolerance** – Dimensions & Tolerance, Limits, Fits and Tolerances, Hole and Shaft Basis, Three datum – functional, machining and manufacturing, geometrical and form tolerance, conventional and advanced tools and techniques for measurements, numerical.	**11**
UNIT-2	**Metal Casting Processes – Gravity Die Casting :** compute the dimensions for Pattern, Mould, based on materials to be cast – ferrous and non-ferrous alloys, influence of parting line, cast holes, special sand cores, shrinkage compensation, numericals, **Pressure Die Casting:** Die casting alloys, machine selection,operation, sub-systems, post-processing equipments, mould design, number of cavities, manufacturing and assembly of moulds, design principles.	**11**
UNIT-3	**Design for Injection Molding –** Injection moulding systems – injection subsystem, ejection system, clamping and feeding system, machine sizing, materials for injection moulding and its properties, injection mould design – cavity and core, manufacturing processes for moulds, operation and cycle time.	**10**
UNIT-4	**Design for Powder Metallurgy Processes**: Introduction to PM process, blending and mixing, compaction, sintering processes. Tooling materials, heat treatment, surface treatments and preparation of green compacts, Press tools for PM process – load, tooling layout, capacity; sintering furnace and influence of process and materials parameters on shrinkage.	**10**
UNIT-5	**Design for Sheet Metal Processing:** Design of moulds for shearing, piercing, bending, deep drawing, progressive die operation, selection of press – hydraulic and electric, sub-systems, turret operation, cycle time calculation, laser cutting of sheet metals. **Cost Estimation** for sand casting, pressure die casting, injection moulding, PM process and sheet metal processes.	**10**

REFERENCE BOOKS:

1. A.K. Chitale and R. C. Gupta, Product Design and Manufacturing, PHI 2007.

2. G.Boothroyd, P.Dewhurst and W.Knight, Product Design for Manufacture and Assembly, Marcell Dekker, 2002.
3. R.Bryan , Fischer, Mechanical Tolerance stackup and analysis, Marcell Dekker, 2004.

4. M. F. Spotts, Dimensioning and Tolerance for Quantity Production, Prentice Hall Inc., 1999.

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	Explain the concept of DFMA and GD&NT.
CO2	Apply engineering products and suggest suitable manufacturing process.
CO3	Evaluate the influence of design, material and manufacturing processes on product assembly.
CO4	Develop appropriate manufacturing and assembly processes for a given product.
CO5	Analyze cost estimation of various metal processes.

MAPPING OF COs WITH POs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1		1	1					1		1	
CO2		1	1					1			1	
CO3	1		1		1				1		1	
CO4	1		1	1					1			
CO5	1			1	1				1		1	

QUESTION PAPER PATTERN (SEE)

Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 **ACADEMIC YEAR: 2021-22**
SEMESTER : SECOND

COURSE TITLE : SMART MATERIALS AND STRUCTURES		
Sub Code: 20MMD263	**No of Credits : L-T-P-SS 3:0:0:0 =3**	**No. of lecture hours/week :04**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks: 50**

COURSE OBJECTIVES:

1. To study the basic sources of smart materials and structures.
2. To acquaint with the effects of Shape memory Alloy, ER and MR fluids.
3. To study the usefulness of vibration absorbers and control of structures.
4. To gain knowledge of MEMS and devices.

#	CONTENTS	Hrs
UNIT-1	**SMART STRUCTURES**: Types of Smart Structures, Potential Feasibility of Smart Structures, Key Elements Of Smart Structures, Applications of Smart Structures. Piezoelectric materials, Properties, piezoelectric Constitutive Relations, Depoling and Coercive Field, field strain relation. Hysteresis, Creep and Strain Rate effects, Inchworm Linear Motor.	11
UNIT-2	**BEAM MODELING:** Beam Modeling with induced strain Rate effects, Inchworm Linear Motor Beam Modeling with induced strain Actuation-single Actuators, dual Actuators, Pure Extension, Pure Bending harmonic excitation, Bernoulli-Euler beam Model, problems, Piezoelectric Applications.	11
UNIT-3	**SHAPE MEMORY ALLOY:** Experimental Phenomenology, Shape Memory Effect, Phase Transformation, Tanaka's Constitutive Model, testing of SMA Wires, Vibration Control through SMA, Multiplexing. Applications Of SMA and Problems. **ER and MR Fluids:** Mechanisms and properties, Fluid Composition and behavior, The Bingham Plastic and Related Models, Pre-Yield Response. Post-Yield flow applications in Clutches, Dampers and Others	10
UNIT-4	**VIBRATION ABSORBERS:** series and Parallel Damped Vibrations (Overview), Active Vibration Absorbers, Fiber Optics, Physical Phenomena. Characteristics, Sensors, Fiber Optics in Crack Detection, applications. **Control of Structures:** Modeling, Control Strategies and Limitations, Active Structures in Practice.	10
UNIT-5	**MEMS** – Mechanical Properties of MEMS Materials, Scaling of Mechanical Systems, Fundamentals of Theory, The Intrinsic Characteristics of MEMS, Miniaturization, Microelectronics Integration. **Devices:** Sensors and Actuators, Conductivity of Semiconductors, Crystal Planes and Orientation, (Stress and Strain Relations, Flexural Beam Bending Analysis Under Simple Loading Conditions), Polymers in MEMS, Optical MEMS Applications.	10

TEXT BOOKS:

1. Smart Materials and Structures -M. V. Gandhi and B.SoThompson, Chapman and Hall, London; New York, 1992 (ISBN: 0412370107).
2. Smart Structures and Materials - B.Culshaw, Artech House, Boston, 1996 (ISBN :0890066817).
3. Smart Structures:Analysis & Design - A. V.Srinivasan, Cambridge University Press, Cambridge; New York, 2001 (ISBN: 0521650267).

REFERENCE BOOKS:

1. Electroceramics: Materials, Properties and Applications - A. J. Moulson and J. M. Herbert. John Wiley & Sons, ISBN: 0471497429
2. Piezoelectric Sensories: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors. Materials and Amplifiers, Springer, Berlin; New York, 2002 (ISBN: 3540422595).
3. Piezoelectric Actuators and Wtrasonic Motors -K.Uchino, Kluwer Academic Publishers, Boston, 1997 (ISBN: 0792398114).

COURSE OUTCOME: At the completion of this course, students will be able to:

CO1	Understand the behaviour and applicability of various smart materials.
CO2	Design Simple models for smart structures and materials.
CO3	Understanding the concepts of shape memory, ER and MR fluids and their characteristics.
CO4	To get knowledge about vibration absorbers and controlling of structures.
CO5	The fundamentals of MEMS and their intrinsic characteristics and devices.

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1		1		1	1				1		1	
CO2	1	1	1		1				1			
CO3		1		1	1						1	
CO4	1	1			1				1			
CO5	1		1		1						1	

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 **ACADEMIC YEAR: 2021-22**
SEMESTER : SECOND

COURSE TITLE: INDUSTRIAL AUTOMATION AND ROBOTICS		
Sub Code: 20MMD264	**No of Credits : L-T-P-SS 3:0:0:0=3**	**No. of Lecture hours/week :04**
Exam Duration:3 hours	**CIE Marks: 50**	**SEE Marks: 50**

COURSE OBJECTIVES:

1. To develop the student's knowledge in various robot structures and their workspace.
2. To develop student's skills in perform kinematics analysis of robot systems.
3. To provide the student with some knowledge and analysis skills associated with trajectory planning.
4. To provide the student with some knowledge and skills associated with robot control and automation.

#	CONTENTS	Hrs
UNIT-1	**Automation and Robotics -** Historical Development, Definitions, Basic Structure of Robots, Robot Anatomy, Complete Classification of Robots, Fundamentals about Robot Technology, Factors related to use Robot Performance, Basic Robot Configurations and their Relative Merits and Demerits, Types of Drive Systems and their Relative Merits, the Wrist & Gripper Subassemblies. Concepts and Model about Basic Control System, Control Loops of Robotic Systems, PTP and CP Trajectory Planning, Control Approaches of Robots	**11**
UNIT-2	**Kinematics of Robot Manipulator**: Introduction, General Description of Robot Manipulator, Mathematical Preliminaries on Vectors & Matrices, Homogenous Representation of Objects, Robotic Manipulator Joint Co-Ordinate System, Euler Angle & Euler Transformations, Roll-Pitch-Yaw(RPY) Transformation, Relative Transformation, Direct & Inverse Kinematics' Solution, D H Representation & Displacement Matrices for Standard Configurations, Geometrical Approach to Inverse Kinematics. Homogeneous Robotic Differential Transformation: Introduction, Jacobian Transformation in Robotic Manipulation	**11**
UNIT-3	**Robotic Workspace & Motion Trajectory**: Introduction, General Structures of Robotic Workspaces, Manipulations with n Revolute Joints, Robotic Workspace Performance Index, Extreme Reaches of Robotic Hands, Robotic Task Description. Robotic Motion Trajectory Design: – Introduction, Trajectory Interpolators, Basic Structure of Trajectory Interpolators, Cubic Joint Trajectories. General Design Consideration on Trajectories: 4-3-4 & 3-5-3 Trajectories, Admissible Motion Trajectories.	**10**
UNIT-4	**Dynamics of Robotic Manipulators**: Introduction, Bond Graph Modeling of Robotic Manipulators, Examples of Bond Graph Dynamic Modeling of Robotic Manipulator. Brief Discussion on Lagrange–Euler (LE) Dynamic Modeling of Robotic Manipulators: - Preliminary Definitions, Generalized Robotic Coordinates, Dynamic Constraints, Velocity & Acceleration of Moving Frames, Robotic Mass Distribution & Inertia Tensors, Newton's Equation, Euler Equations, The Lagrangian& Lagrange's Equations. Application of Lagrange–Euler (LE) Dynamic Modeling of Robotic Manipulators: - Velocity of Joints, Kinetic Energy T of Arm, Potential Energy V of Robotic Arm, The Lagrange L, Two Link Robotic Dynamics with Distributed Mass,	**10**

	Dynamic Equations of Motion for A General Six Axis Manipulator.	
UNIT-5	**Autonomous Robot**: Locomotion Introduction, Key issues for locomotion Legged Mobile Robots Leg configurations and stability Examples of legged robot locomotion Wheeled Mobile Robots Wheeled locomotion: the design space Wheeled locomotion: case studies Mobile Robot Kinematics Introduction Kinematic Models and Constraints Representing robot position Forward kinematic models Wheel kinematic constraints Robot kinematic constraints, Mobile Robot manoeuvrability Degree of mobility Degree of steerability Robot manoeuvrability.	**10**

REFERENCE BOOKS:

1. A Robot Engineering Textbook, Mohsen Shahinpoor, Harper & Row publishers, New York. ISBN:006045931X
2. Robotics, control vision and intelligence, Fu, Lee and Gonzalez, McGraw Hill International. ISBN:0070226253
3. Introduction to Robotics, John J. Craig, Addison Wesley Publishing, ISBN:0201543613

4. Autonomous mobile robots, Roland Illah R. Siegwart Nourbakhsh, The MIT Press Cambridge, Massachusetts London, England, 2004.ISBN:0262015358

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	Analyze the manipulator design including actuator, drive and sensor issues.
CO2	Calculate the forward kinematics, inverse kinematics and jacobian industrial robots.
CO3	Solve trajectory and dynamic related robotic problems.
CO4	Evaluate the different configurations and stability of autonomous robots.
CO5	Understand the concept of autonomous robot.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1		1		1	1				1		1	
CO2	1	1	1		1				1			
CO3		1		1	1						1	
CO4	1	1			1				1			
CO5	1		1		1						1	

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2021-22 **ACADEMIC YEAR: 2021-22**
SEMESTER : SECOND

COURSE TITLE: ANALYSIS LAB		
Sub Code: 20MMDL28	**No of Credits : L-T-P-SS 0:0:3:0=2**	**No. of Lecture hours/week :03**
Exam Duration:3 hours	**CIE Marks: 50**	**SEE Marks: 50**

COURSE OBJECTIVES:

1. To be able to understand and handle design problems in systematic manner
2. To gain practical experience in 2D drafting and 3D modeling software systems.
3. To be able to apply CAD in real life applications.
4. To be able to understand various software used to solve the practical problems.

PART	CONTENTS	Hrs.
A	**I. Study of a FEA package and modelling stress analysis of** ➢ Bars of constant cross section area and stepped bar ➢ Trusses- (Minimum 6 exercises) ➢ Beams - Simply supported, cantilevr. beams with UDL, beams with varying load.etc (Minimum 10 exercises) .	**02** **08** **10**
B	**I. Thermal Analysis** - 2D problem with conduction and convection boundary conditions (Minimum 4 exercises) **II. Fluid flow Analysis** - Potential distribution in the 2 - D bodies **III. Dynamic Analysis** ➢ Fixed- fixed beam for natural frequency determination ➢ Bar subjected to forcing function ➢ Fixed- fixed beam subjected to forcing function	**6** **4** **12**

REFERENCE BOOKS:

1. **ANSYS Workbench Tutorial Release 14,** Structural and Thermal Analysis Using Ansys
2. Mechanical APDL Release 14 Environment, Kent Lawrence, Schroff Development Corporation,
3. Website: www.SDCpublications.com
4. **Practical Finite Element Analysis,** Nitin S. Gokhale, Sanjay S. Despande, Dr. Anand N. Thite,

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	Apply basics of theory of elasticity to continuum problems.
CO2	Formulate finite elements like bar, truss and beam elements for linear static Structural analysis.
CO3	Formulate 2d and axis-Symmetric finite elements.
CO4	Develop finite element equations for 1d heat transfer elements and solve Numerical.
CO5	Apply finite element simulation tool to solve practical problems (lab and Self-study).

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1		1					1			
CO2	1	1		1							1	
CO3	1		1	1					1			
CO4		1		1	1				1		1	
CO5	1			1	1				1			

SCHEME FOR CONTINOUS INTERNAL EVALUATION (CIE)	
Evaluation of lab manual	30 Marks
Internal evaluation	10 Marks
Viva-voce	10 Marks
Total	**50 Marks**

SEMESTER END EXAMINATION (SEE)					
Sl. No.	**Particulars**	**Max. Marks**	**Break Up of Max. Marks**		
			Write Up	**MODELLING**	**ANALYSIS**
1	PART -A	**15**	05	05	05
2	PART-B	**25**	05	10	10
3	Viva Voce	**10**	--	--	--
TOTAL MARKS		**50**	**10**	**25**	**15**

- Two Full Questions to be set.
- Students shall be to be answered two full Questions.
- Each question(Experiments contains different Marks and it is clearly mentioned in the above table)
- Changing of Experiments is not allowed from any unit
- Viva Voce is compulsory

ADMISSION YEAR : 2021-22 **ACADEMIC YEAR: 2021-22**
SEMESTER : SECOND

COURSE TITLE: PROJECT WORK PHASE -I		
Sub Code: 20MMDP29	**No of Credits : L-T-P-SS 0:0:0:12=06**	**No. of Lecture hours/week : -----**
Exam Duration:---------	**CIE Marks: 50**	**SEE Marks :---------**

COURSE OBJECTIVES:

1. Support independent learning.
2. A aim of identifying a problem in the area relevant to the program.
3. To formulate a research problem in the area relevant to the program
4. Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.

GUIDELINES

1. The Project Work will start in Third semester and should preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution.
2. The students are required to take up a project work relevant to the course, which involves
   - Introduction
   - literature review
   - problem formulation
   - methodology
   - analysis of results and discussion
   - future scope and conclusion
3. The candidate has to be in regular contact with his guide and the topic of dissertation must be mutually decided by the guide and student.
4. Extensive survey should be based on the area of specialization in which the candidate wish to do the dissertation work.
5. The student should prepare a report consisting of a detailed problem statement and a literature review. The preliminary results (if available) of the problem may also be discussed in the report.
6. Present the seminar on the selected project through power point slides.
7. The work has to be presented in front of the examiners panel set by Head of Department.

Scheme for Continuous Internal Evaluation (CIE) :

CIE marks for the report (20 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department, The committee shall consist of three faculty from the department in the area of specialization.

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	Demonstrate a sound technical knowledge of their selected project topic.
CO2	Will be able to identify a problem in the area relevant to the program through literature survey.
CO3	The candidate would have prepare a consolidated report of the problem formulation.
CO4	Design engineering solutions to complex problems utilising a systems approach.
CO5	Demonstrate the knowledge, skills and attitudes of a design engineer.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1		1		1				1		1	
CO2		1		1		1			1		1	
CO3	1		1		1				1		1	
CO4	1		1			1				1		
CO5		1		1		1				1		

ADMISSION YEAR: 2020-21 **ACADEMIC YEAR: 2021-22**

SEMESTER: THIRD

COURSE TITLE: SELF STUDY – MASSIVE OPEN ONLINE COURSE (MOOC)		
Sub Code: 20MMD31	**No of Credits : L-T-P-SS 0:0:0:06=03**	**No. of Lecture hours/week :**
Exam Duration:3 Hrs.	**CIE Marks: 50**	**SEE Marks: 50**

GUIDELINES

- The student shall choose and register for any of the following NPTEL/SWAYAM core course amounting to a minimum of 16 weeks.
- List of Massive Open Online Courses (NPTEL/SWAYAM) will be decided in the Board of Studies meeting.
- Students shall register for MOOC during 1^{st} /2^{nd} /3^{rd} semester and shall be completed before the last working day of the 3^{rd} semester.
- The student shall choose a MOOC subject which is confined to his specialization and part of his final year thesis.
- The assignment and examination marks along with certificate should be submitted to the examination section.

Sl. No.	MOOC SUBJECT NAME
1.	Gas Dynamics and propulsion
2.	Nonlinear vibrations
3.	Modelling and control of Dynamic Electro Mechanical System
4.	Computer aided engineering design
5.	Kinematics of machines
6.	Finite Element Method: Variation Methods to Computer Programming
7.	Selection of Nanomaterials For Energy Harvesting And Storage Application
8.	Introduction to Mechanical Micro Machining
9.	Transport Phenomena in materials

ADMISSION YEAR: 2020-21 ACADEMIC YEAR: 2021-22
SEMESTER: THIRD

COURSE TITLE: INTERNSHIP		
Sub Code: 20MMDI32	**No of Credits : L-T-P-SS 0:0:0:16=08**	**No. of Lecture hours/week :**
Exam Duration:3 Hrs.	**CIE Marks: 50**	**SEE Marks :50**

COURSE OBJECTIVES:

1. Expose technical students to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry.
2. Provide possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job.
3. Expose students to the engineer's responsibilities and ethics.
4. Understand the psychology of the workers and their habits, attitudes and approach to problem solving.

GUIDELINES
1. Internship must be related to the field of specialization. 2. The duration of the internship shall be for a period of 16 weeks on full time basis after II semester SEE exams. 3. Two guides will supervise the internship project work, one from the department and another one from industry. 4. The student must submit letters from the industry clearly specifying his / her name and the duration of the internship on the company letter head with authorized signature. 5. The candidate should submit a synopsis of the proposed work to be done during Internship programme. The synopsis received should be evaluated by the departmental committee. 6. The students shall report the progress of the internship to the internal guide twice in a month and seek internal guide advice. 7. Interim reports as required by the industry / organization can be submitted as per the format acceptable to the respective industry /organizations. 8. Students have to present the internship activities carried out to the departmental committee and only upon approval by the committee, the student can proceed to prepare and submit the hard copy of the final internship report. 9. The final project presentation is evaluated on the basis of the recommendation given by outside supervisor and Internal guide. 10. The external guide from the industry has to be an examiner for the viva voce on Internship. Viva-Voce on internship shall be conducted at the college and the date of Viva-Voce shall be fixed in consultation with the external Guide. The Examiners shall jointly award the Viva - Voce marks.

SCHEME FOR CONTINUOUS INTERNAL EVALUATION (CIE)
CIE marks for the Internship report (30 marks), seminar (10 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department, The committee shall consist of three faculty from the department.

SCHEME FOR SEMESTER END EVALUATION (SEE)
The SEE examination shall be conducted by an external examiner (domain expert) and an internal examiner. Evaluation done in Individually.

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	The purpose of the student internship program is to provide students with an opportunity to gain workplace skills
CO2	The internship will provide training that would be similar to that which would be given in an educational environment, including the Work Station and other hands-on training provided by educational institutions
CO3	Excellent opportunity to see how the theoretical aspects learned in classes are integrated into the practical world.
CO4	Opportunity to learn strategies like time management, multi-tasking etc. in an industrial setup.
CO5	Opportunity to learn new skills and supplement knowledge

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1			1							1	
CO2		1		1								
CO3	1		1	1							1	
CO4		1										
CO5	1			1		1					1	

ADMISSION YEAR: 2020-21 **ACADEMIC YEAR: 2021-22**

SEMESTER: THIRD

COURSE TITLE: TECHNICAL SEMINAR		
Sub Code: 20MMDS33	**No of Credits : L-T-P-SS 0:0:2:0=02**	**No. of Lecture hours/week :**
Exam Duration: 3 Hrs.	**CIE Marks: 50**	

COURSE OBJECTIVES:

1. Exposure of students to a variety of research projects and activities in order to enrich their academic experience.
2. An opportunity for students to develop skills in presentation and discussion of research topics in a public forum.
3. To identify good journals and journal papers; study the papers and understand, analyze, interpret and explain the contents of the paper.

GUIDELINES

1.Each student, under the guidance of a Faculty, is required to

- Choose, preferably through peer reviewed journals, a recent topic of his/her interest relevant to the Course of Specialization.
- Carryout literature survey, organize the Course topics in a systematic order.
- Prepare the report with own sentences.
- Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.
- Present the seminar topic orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

2. All students should attend the seminars of other students of their specialization.

SCHEME FOR CONTINUOUS INTERNAL EVALUATION (CIE)

Each presentation shall be evaluated for 50 marks. Average marks obtained for three best presentations will be the student's CIE marks.

Marks distribution

- Seminar Report: 20 marks
- Presentation skill:20 marks
- Viva Voce:10 marks

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	To identify good journals and journal papers
CO2	study the papers and understand, analyze, interpret and explain the contents of the paper
CO3	understand the shortcomings and plus points of published papers
CO4	To develop overall skills for technical communication and help technical decision making
CO5	To understand the latest research in their field of study

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1		1		1	1			1		1	
CO2		1		1					1		1	
CO3	1		1		1				1		1	
CO4		1		1					1		1	
CO5	1		1		1						1	

ADMISSION YEAR: 2020-21 **ACADEMIC YEAR: 2021-22**

SEMESTER: THIRD

COURSE TITLE: EVALUATION OF PROJECT WORK PHASE I		
Sub Code: 20MMDP34	**No of Credits : L-T-P-SS 0:0:0:14=07**	**No. of Lecture hours/week : -----**
Exam Duration:3 Hrs.	**CIE Marks: 50**	**SEE Marks :50**

COURSE OBJECTIVES:

1. Support independent learning.
2. The aim is to identify a problem in the area relevant to the program.
3. To formulate a research problem in the area relevant to the program
4. Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.

GUIDELINES

1. Evaluation of Project Work Phase I is continuation of Phase - I.
2. The duration of the Phase-II shall be of 16 weeks.
3. The student needs to complete the project work in terms of literature survey, objectives of the work and methodology.
4. The preliminary results (if available) of the problem may also be discussed in the report.
5. The student should prepare a report consisting of a detailed Literature Review and Methodology.
6. Present the seminar on the selected project through power point slides.

. The work has to be presented in front of the examiners panel set by Head of Department.

Scheme for Continuous Internal Evaluation (CIE) :

CIE marks for the report (20 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department, The committee shall consist of three faculty from the department in the area of specialization.

Semester End Examination (SEE) :

Project Report: 20 Marks.

- The basis for awarding the marks shall be the involvement of the student in the project and in the preparation of project report.
- To be awarded by the internal guide in consultation with external guide if any.

Project Presentation: 20 Marks.

- The Project Presentation marks of the **Evaluation Of Project Work Phase -I** shall be awarded by the committee constituted for the purpose by the Head of the Department.
- The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

Viva Voce: 10 Marks.

The student shall be evaluated based on the ability in the Question and Answer session for 10 marks.

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
CO2	Habituated to critical thinking and use problem solving skills.
CO3	The candidate would have applied the technical knowledge learnt to prepare a methodology to solve the research problem formulated.
CO4	The candidate would have conducted the experiments according the standards acceptable by the peers.
CO5	Understand experimental investigations to verify predictions by other methods.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1		1		1				1		1	
CO2		1		1				1	1			
CO3	1		1		1						1	
CO4		1			1				1		1	
CO5	1		1		1							

ADMISSION YEAR: 2020-21 **ACADEMIC YEAR: 2021-22**

SEMESTER: FOURTH

COURSE TITLE: PROJECT PHASE- II		
Sub Code: 20MMDP41	**No of Credits : L-T-P-SS 0:0:0:08=02**	**No. of Lecture hours/week: -----**
Exam Duration: 3 Hours	**CIE Marks: 100**	

COURSE OBJECTIVES:

1. To expand intellectual capacity, credibility, judgement, intuition.
2. To impart flexibility and adaptability.
3. The candidate should be able to prepare a comprehensive report of the project work.
4. To induce responsibilities to oneself and others.

GUIDELINES

1. Project Phase -II is continuation of Evaluation of Project Work Phase -I.
2. The duration of the Phase-II shall be of 16 weeks.
3. The student needs to complete the project work in terms of methodology (experimental set up or numerical details as the case may be) of solution and Results.
4. The student is expected to exert on design, development and testing of the proposed work.
5. The student should prepare a report consisting of a detailed report comprising of summary of literature survey, detailed objectives, project specifications, paper and/or computer aided design, proof of concept/functionality, part results, A record of continuous progress.
6. Present the seminar on the selected project through power point slides.
7. The work has to be presented in front of the examiners panel set by Head of Department.

Scheme of Continuous Internal Examination (CIE)

Evaluation shall be carried out in three reviews. The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor.

	Activity	**Marks**
1.	Review and refinement of Objectives and Literature Review	20
2.	Project Specifications, Computer Aided Design	40
3.	Experimental Result & Analysis	40
	Total	100

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	Work in a team to achieve common goal.
CO2	Learn on their own, reflect on their learning and take appropriate actions to improve it.
CO3	Communicate the solutions through presentations and technical reports.
CO4	Enhance presentation skills and report writing skills.
CO5	Develop alternative solutions which are sustainable.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1			1					1		1	
CO2		1		1					1			
CO3	1		1								1	
CO4	1	1		1								
CO5	1			1					1		1	

ADMISSION YEAR: 2020-21 **ACADEMIC YEAR: 2021-22**

SEMESTER: FOURTH

COURSE TITLE: PROJECT WORK EVALUATION AND VIVA VOCE		
Sub Code: 20MMDP42	**No of Credits : L-T-P-SS 0:4:0:24=18**	**No. of Lecture hours/week : -----**
Exam Duration:3 Hrs.	**CIE Marks: 100**	**SEE Marks :100**

COURSE OBJECTIVES:

1. To expand intellectual capacity, credibility, judgement, intuition.
2. To impart flexibility and adaptability.
3. The candidate should be able to prepare a comprehensive report of the project work.
4. To induce responsibilities to oneself and others.

GUIDELINES
1. Project Phase -II is continuation of Evaluation of Project Work Phase -I. 2. The duration of the Phase-II shall be of 16 weeks. 3. The student needs to complete the project work in terms of results and discussion of the Experimentation and Analysis of the defined problem. 4. The student should bring out the conclusions of the work and future scope for the study. 5. The student should prepare a report consisting of a detailed report comprising of summary of literature survey, detailed objectives, project specifications, paper and/or computer aided design, proof of concept/functionality, part results, A record of continuous progress. 6. The student should prepare the project report as per the norms avoiding plagiarism. 7. The student should present the seminar on the selected project through power point slides. 8. The work has to be presented in front of the examiners panel set by Head of Department.

SCHEME FOR SEMESTER END EVALUATION (SEE):

Major Project Phase-II SEE shall be conducted in two stages. This is initiated after fulfilment of submission of project report.

Stage-1:
<u>Evaluation of Report</u>

Evaluation of Project Report shall be done by guide and an external examiner.

Stage-2:
<u>Project Viva-voce</u>

Major Project Viva-voce examination is conducted after receipt of evaluation reports from guide and external examiner.

Both Stage-1 and Stage-2 evaluations shall be completed as per the evaluation formats**.**

SCHEME FOR SEMESTER END EVALUATION (SEE)			
Details	**Internal Guide**	**External Guide**	**Total**
Report Evaluation	100 Marks	100 Marks	**200 Marks**
Viva-Voce	Joint evaluation by Internal Guide & External Evaluator		**100 Marks**
		Total	**300 Marks**

COURSE OUTCOMES: After the completion of this course, student will be able to:

CO1	The student will develop attitude of lifelong learning
CO2	The student will learn to write technical reports and research papers to publish at national and international level
CO3	The Student will develop strong communication skills to defend their work in front of technically qualified audience
CO4	The student will be able to either work in a research environment or in an industrial environment
CO5	Synthesize self-learning, sustainable solutions and demonstrate life-long learning.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1		1						1		1	
CO2		1	1		1				1		1	
CO3	1		1		1				1		1	
CO4	1	1			1				1			
CO5		1			1				1		1	