Dr. Ambedkar Institute of Techonolgy
Department of Mechanical Engineering

The documents enclosed are verified and approved.

HOD
Dept. of Mechanical Engineering

HOD
Department of Mechanical Engineering
Dr. Ambedkar Institute of Technology
Bengaluru - 560 056.

Panchajanya Vidya Peetha Welfare Trust (Regd)

Dr. Ambedkar Institute of Technology

An Autonomous Institution, Affiliated to Visvesvaraya Technological University, Belagavi,
Aided by Govt. of Karnataka, Approved by All India Council for Technical Education (AICTE), New Delhi
Accredited by NBA and NAAC with 'A' Grade
BDA Outer Ring Road, Mallathalli, Bengaluru - 560 056

Ref. No. .....

Date : .....

This is to certify that the list of courses for the Employability,Entrepreneurship and skill development have been introduced during the last five years with the approval from the BOS chairman and BOS Members

Sl.No	Subject	Subject Code	Activities/content with direct bearing on Employability/ Entrepreneurship/skill development.
1.	Fluid Mechanics	ME31	Employability & Skill development
2.	Basic Thermodynamics	ME32	Employability & Skill development
3.	Mechanics Of Materials	ME33	Employability & Skill development
4.	Manufacturing Process – I	ME34	Employability & Skill development
5.	Metrology And Measurements	ME35	Employability & Skill development
6.	Manufacturing Process – II	ME44	Employability & Skill development
7.	Material Science And Metallurgy	ME45	Employability & Skill development
8.	Design Of Machine Elements – I	ME51	Employability & Skill development
9.	Dynamics Of Machines	ME52	Employability & Skill development
10.	Heat Transfer	ME53	Employability & Skill development
11.	Computer Aided Design And Manufacturing	ME54	Employability & Skill development
12.	Experimental Stress Analysis	ME551	Employability & Skill development
13.	Advanced Manufacturing Processes	ME552	Employability & Skill development
14.	Power Plant Engineering	ME553	Employability & Skill development

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Date : .....

15.	Theory Of Elasticity	ME561	Employability & Skill development
16.	Design Of Machine Elements – II	ME61	Employability & Skill development
17.	Finite Element Methods	ME62	Employability & Skill development
18.	Mechanical Vibrations	ME63	Employability & Skill development
19.	Operations Research	ME64	Employability & Skill development
20.	Inspection And Quality Control	ME651	Employability & Skill development
21.	Product Design & Manufacturing	ME652	Employability & Skill development
22.	Control Engineering	ME71	Employability & Skill development
23.	Hydraulics And Pneumatics	ME72	Employability & Skill development
24.	Rapid Prototyping	ME731	Employability & Skill development
25.	Internal Combustion Engines (Core Elective)	ME732	Employability & Skill development
26.	Computer Aided Machine Drawing	18MEL35	Skill Development
27.	Manufacturing Processes Laboratory - I	18MEL36	Employability
28.	Material Testing Laboratory	18MEL37	Skill Development
29.	Fitting and Forging Workshop	18MEL38	Skill Development
30.	Fluid Mechanics	18ME42	Employability
31.	Applied Thermodynamics	18ME44	Employability
32.	Kinematics of Machines	18ME45	Employability
33.	Manufacturing Processes Laboratory - II	18MEL46	Skill Development
34.	Mechanical Measurements Laboratory	18MEL47	Skill Development
35.	Computer Aided Design and Manufacturing	18ME54	Skill Development

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Ref. No. .....

Date : .....

36.	Engineering Economics	18ME551	Entrepreneurship
37.	Composite Materials and Manufacturing	18ME552	Employability
38.	Automobile Engineering	18ME553	Employability
39.	Mechatronics And Microprocessor	18ME554	Employability
40.	Computer Aided Manufacturing Laboratory	18MEL56	Skill Development
41.	Fuel Testing And Internal Combustion Engines Laboratory	18MEL57	Skill Development
42.	Heat Transfer	18ME62	Employability
43.	Mechanical Vibrations	18ME63	Employability
44.	Finite Element Methods	18ME645	Employability
45.	Fluid Power Control Systems	18ME646	Employability
46.	Fluid Mechanics And Machines Laboratory	18MEL65	Skill Development
47.	Heat Transfer Laboratory	18MEL66	Skill Development
48.	Mini - Project Work	18MEP67	Skill Development
49.	Engineering Economics	ME733	Entrepreneurship
50.	Computer Aided Modeling And Analysis Laboratory	MEL74	Skill Development
51.	Project Work Phase – I	MEP75	Skill Development
52.	Smart Materials	ME813	Entrepreneurship
53.	Control Engineering Laboratory	MEL82	Skill Development
54.	Seminar	MES83	Entrepreneurship
55.	Project Work Phase – I	MEP84	Skill Development

BOS Chairman
Department of Mechanical Engineering
Dr. Ambedkar Institute of Technology
Bengaluru - 560 056.

Principal
PRINCIPAL
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Bengaluru-560 056

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 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.	**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

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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 : 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

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 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.	

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 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

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 radioactivities 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	

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, 2nd 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 Isoparametric, 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

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 : 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 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	
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 12th 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 12th 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 CUTTIN**G (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 MACHINE**S (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 MACHINE**S (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

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 : 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.	**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.

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 : 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 : 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 centrifugual 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.

   $$V = IZ \text{ ……. } (3.2)$$

   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.

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 : 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**