Dr. Ambedkar Institute of Technology, Bengaluru-560 056
SCHEME OF TEACHING AND EXAMINATION from Academic Year 2021-22
B.E MECHANICAL ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
III SEMESTER

Sl .No	Course and Course Code		Course Title	Teaching Department	Teaching Hours / Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
01	BC	18MA31	Transforms & Boundary Value Problems	Mathematics	2	2	--	03	50	50	100	3
02	PC	18ME31	Material Science	Mechanical	3	0	--	03	50	50	100	3
03	PC	18ME32	Mechanics of Materials	Mechanical	3	2	--	03	50	50	100	4
04	PC	18ME33	Manufacturing Processes - I	Mechanical	3	0	--	03	50	50	100	3
05	PC	18ME34	Basic Thermodynamics	Mechanical	3	2	--	03	50	50	100	4
06	PC	18MEL35	Computer Aided Machine Drawing	Mechanical	2	0	2	03	50	50	100	3
07	PC	18MEL36	Manufacturing Processes Laboratory - I	Mechanical	--		2	03	50	50	100	1
08	PC	18MEL37	Material Testing Laboratory	Mechanical	--		2	03	50	50	100	1
09	PC	18MEL38	Fitting and Forging Workshop	Mechanical	--	--	2	03	50	50	100	1
10	HS	18HS31/32	Constitution of India Professional Ethics and Human Rights / Environmental Studies	Humanities	1	--	0	02	50	50	100	1
11	NC MC	18HS33	Soft Skills (MC)	Humanities	2	--	--	03	50	-	50	PP/ NP
TOTAL					**19**	**06**	**08**	**32**	**550**	**500**	**1050**	**24**

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs												
12	HS	18HS34	Placement Training	Humanities	02	--	--	03	50	-	50	PP/NP
13	MC	18MAD31	Advance Mathematics-I	Mathematics	02	01	--	03	50		50	PP/NP

Note: HODs are informed to accommodate one more laboratory in addition to the above courses if needed, without altering the total number of credits (TOTAL: 24).

(a) **The mandatory non – credit courses** Advance Mathematics I and II prescribed at III and IV semesters respectively, to lateral entry Diploma holders admitted to III semester of BE programs shall compulsorily be registered during respective semesters to complete all the formalities of the course and appear for SEE examination.

(b) **The mandatory non – credit courses** Advance Mathematics I and II, prescribed to lateral entrant Diploma holders admitted to III semester of BE programs, are to be completed to secure eligibility to VII semester. However, they are not considered for vertical progression from II year to III year of the programme but considered as head of passing along with credit courses of the programme to eligibility to VII semester.

Note: BC: Science Course, PC: Professional Core. Hu: Humanities, NCMC: Non-Credit Mandatory Course.

Dr. Ambedkar Institute of Technology, Bengaluru-560 056
SCHEME OF TEACHING AND EXAMINATION from Academic Year 2021-22
B.E MECHANICAL ENGINEERING
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IV SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
01	BC	18MA41	Numerical Methods & Applied Statistics	Mathematics	2	2		03	50	50	100	3
02	PC	18ME41	Mechanical Measurements	Mechanical	3	0	--	03	50	50	100	3
03	PC	18ME42	Fluid Mechanics	Mechanical	3	2	--	03	50	50	100	4
04	PC	18ME43	Manufacturing Processes - II	Mechanical	3	0	--	03	50	50	100	3
05	PC	18ME44	Applied Thermodynamics	Mechanical	3	2	--	03	50	50	100	4
06	PC	18ME45	Kinematics of Machines	Mechanical	3	2	--	03	50	50	100	4
07	PC	18MEL46	Manufacturing Processes Laboratory - II	Mechanical	--	--	2	03	50	50	100	1
08	PC	18MEL47	Mechanical Measurements Laboratory	Mechanical	--	--	2	03	50	50	100	1
09	HS	18HS41/42	Constitution of India Professional Ethics and Human Rights / Environmental Studies	Hum/Civil	1	--	--	02	50	50	100	1
10	NC MC	18HS43	Employability Skills (MC)	Humanities	2	--	--	03	50	-	50	PP/ NP
				TOTAL	**20**	**08**	**04**	**29**	**500**	**450**	**950**	**24**

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs

11	HS	18HS44	Placement Training	Humanities	02	--	--	03	50	-	50	PP/ NP
12	MC	18MAD41	Advance Mathematics-II	Mathematics	02	01	--	03	50		50	PP/ NP

Note: HODs are informed to accommodate one more laboratory in addition to the above courses if needed, without altering the total number of credits (TOTAL: 24).

(a) The mandatory non – credit courses Advance Mathematics I and II prescribed at III and IV semesters respectively, to lateral entry Diploma holders admitted to III semester of BE programs shall compulsorily be registered during respective semesters to complete all the formalities of the course and appear for SEE examination.

(b) **The mandatory non – credit courses** Advance Mathematics I and II, prescribed to lateral entrant Diploma holders admitted to III semester of BE programs, are to be completed to secure eligibility to VII semester. However, they are not considered for vertical progression from II year to III year of the programme but considered as head of passing along with credit courses of the programme to eligibility to VII semester.

Note: BC: Science Course, PC: Professional Core. Hu: Humanities, MC: Mandatory Course.
ENV: Environmental Studies, CIP: Constitution of India Professional Ethics and Human Rights

ADMISSION YEAR : 2020-21 ACADEMIC YEAR: 2021-22
SEMESTER : THIRD

COURSE TITLE: MATERIAL SCIENCE		
Sub Code:18ME31	**No of Credits =3** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks: 50**
Pre-requisites	**Engineering Physics & Chemistry**	

COURSE OBJECTIVES:

1. Know the fundamental science and engineering principles relevant to engineering materials.
2. Understand the intricacies involved in characterization, processing and design of materials.
3. Have the necessary theoretical and experimental skills for a pursuit in professional career.
4. Possess an intrinsic knowledge of the significance of different materials, the value of continued learning and environmental / social issues surrounding materials.
5. The student should be able to understand all basic principles involved in the application of materials for different engineering sectors.

#	CONTENTS	Hrs.
UNIT 1	**CRYSTAL STRUCTURES, MECHANICAL BEHAVIOUR AND PLASTIC DEFORMATION**	**08**
	Introduction to types of crystal structures, imperfection in solids, diffusion, stress-strain diagram showing ductile and brittle behaviour of materials, linear and nonlinear elastic behaviour and properties, mechanical properties in plastic region, yield strength, offset yield strength, ductility, malleability, ultimate tensile strength, toughness. Plastic deformation of single crystal by slip and twinning, strain hardening and strain aging, simple problems on stress and strain.	
UNIT 2	**FRACTURE, CREEP AND FATIGUE**	**07**
	Types of fracture, Griffith criteria for brittle fracture, distinguishing features of brittle and ductile fracture. Three stages of creep deformation and creep properties. Types of fatigue loading with examples, mechanism of fatigue, fatigue properties, fatigue testing and SN diagram.	
UNIT 3	**SOLIDIFICATION AND PHASE DIAGRAMS**	**08**
	Mechanism of solidification, homogenous and heterogeneous nucleation, crystal growth, cast metal structures. Solid solutions Hume Rothary rule, substitutional and interstitial solid solutions, intermediate phases and Gibbs phase rule. Types of phase diagrams, construction of equilibrium diagrams involving complete and partial solubility, lever rule, and simple problems on phase diagrams. Iron carbon equilibrium diagram, description of phases.	
UNIT 4	**HEAT TREATMENT AND FERROUS ALLOYS**	**08**
	TTT curves, continuous cooling curves (CCT), Annealing and its types, normalizing, hardening, tempering, martempering, austempering, hardenability, surface hardening methods like carburizing, cyaniding, nitriding, flame hardening and induction hardening. Steel and its classification, properties, composition and applications of Grey cast iron, malleable iron.	
UNIT 5	**NON-FERROUS ALLOYS AND COMPOSITE MATERIALS**	**08**

	Copper alloys-brasses and bronzes; Aluminum alloys-Al-Cu, Al-Si, Al-Zn alloys; **Composite materials:** classification, properties, characteristics, and applications of PMCs, MMCs, CMCs and Carbon-Carbon Composites. **Biomaterials:** Introduction, Materials used as biomaterials, advantages, disadvantages and applications.	

TEXT BOOKS:

1. Foundations of Materials Science and Engineering, Smith, 3rd Edition McGraw Hill, 2009
2. Materials Science, Shackleford and M. K. Muralidhara, Pearson Publication –2007.
3. Material Science, by Callister, Reprint 2008, Wiley India (P) LTD.
4. Material Science by V. Raghavan, Fifth Edition, PHI (P) LTD.
5. Introduction to physical metallurgy by Avner S H, 2nd Ed., MHP, 1985
6. Sujata V. Bhat, Biomaterials, Narosa Publishing House, 2002.

REFERENCE BOOKS:

1. Elements of Materials Science and Engineering, H. Van Vlack
2. Engineering Materials Science, W.C. Richards, PHI, 1965.
3. Physical Metallurgy; Lakhtin, Mir Publications.
4. Material Science and Engineering (SI Units), R.K. Rajput
5. Smart Materials and Structures, M V Gandhi and B S Thompson Chapmen &Hall
6. Material science and Metallurgy by K R Phaneesh, Sudha Publications-2005

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

CO1: Differentiate crystal structures, imperfections, diffusion in solids, elastic and plastic properties of metal materials.

CO2: Analyze the various types of fracture, stages of creep and fatigue failure.

CO3: Describe mechanism of solidification, cast metal structure and rules for formation of solid solution.

CO4: Develop a capability to read a binary phase diagram and predict the properties that can be obtained by heat treatment and to know the characteristics and application of ferrous metals.

CO5: Know the different characteristics of nonferrous metals and their applicability for different applications and also know the physical and mechanical properties of composite materials also introduced to biomaterials.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1	1	2	1	0	1	2	0	1	0	3
CO2	2	1	1	2	1	0	1	2	0	1	0	3
CO3	2	1	1	2	1	0	1	2	0	1	0	3
CO4	2	2	1	2	1	0	1	2	0	1	0	3
CO5	2	1	1	2	1	0	1	2	0	1	0	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2020-21 ACADEMIC YEAR: 2021-22
SEMESTER : THIRD

COURSE TITLE : MECHANICS OF MATERIALS		
Sub Code: 18ME32	**No of Credits =4** **L-T-P-SS::3:2:0:0**	**No. of contact hours/week : 3L+2T** **Total Number of contact hours : 65**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks: 50**
Pre-requisites	**Basic Engineering Mathematics**	

COURSE OBJECTIVES:

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

#	CONTENTS	Hrs.
UNIT-1	**SIMPLE STRESS AND STRAIN**	**10L+5T**
	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**	**12L+5T**
	Introduction, Types of beams, loads and reactions, shear forces and bending moments, rate of loading, sign conventions, relationship between shear force and bending moments. Shear force and bending moment diagrams for different beams subjected to concentrated loads, uniformly distributed load, (UDL) uniformly varying load (UVL) and couple for different types of beams. Bending and Shear Stresses in Beams: Introduction, Theory of simple bending, assumptions in simple bending. Bending stress equation, relationship between bending stress, radius of curvature, relationship between bending moment and radius of curvature.	
UNIT-3	**DEFLECTION OF BEAMS**	**10L+4T**

	Moment carrying capacity of standard sections. Shearing stresses in beams, shear stress across rectangular, circular, symmetrical I and T sections. (Composite / notched beams not included). Introduction, differential equation for deflection. Equations for deflection, slope and bending moment. Double integration method for cantilever and simply supported beams for point load, UDL, UVL and Couple. Macaulay's method, Energy Methods: Work, strain energy, Strain energy in bar/beams due to various loads.	
UNIT-4	**TORSION OF CIRCULAR SHAFTS & ELASTIC STABILITY OF COLUMNS**	**6L+3T**
	Introduction. Pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts. Power transmitted by solid and hollow circular shafts columns**:** Euler's theory for axially loaded elastic long columns. Derivation of Euler's load for various end conditions, limitations, Rankine's formula.	
UNIT-5	**CYLINDERS AND SPHERES**	**7L+3T**
	CYLINDERS Stresses in thin cylinders due to internal pressure, circumferential stresses & longitudinal stresses. Deformation in thin cylinders, stresses due to internal pressure of thick cylinders, Lame's theory and numerical problem. Numerical. **SPHERES** Thin spherical shells**,** This cylinder with hemispherical ends , Biaxial stresses in doubly curved walls of pressure vessels, stresses in a conical water tank, Numerical, Thick spherical shells, Derivation of radial and hoop stresses , Numerical	

TEXT BOOKS:

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

2.**"Strength of Materials", S. Ramamrutham**

REFERENCE BOOKS:

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

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

CO1: Evaluate fundamental concepts of stresses, strains applied to members under loadings and material properties.

CO2: Understand the SFD and BMD for different types of loads and support conditions and relate bending stress, bending moment, radius of curvature.

CO3: Analyze Shear stresses in beams of different cross sections analyze the deflection in beams and Estimate the strain energy in mechanical elements.

CO4: Characterize torsional equation, power transmission in shafts and analyze buckling and bending phenomenon in columns, struts and beams

CO5: Analyze and design thin, thick cylinders and plates, shells.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	2	1	1	1	1	2	1	1
CO2	3	3	2	3	1	1	1	2	1	1	1	2
CO3	3	3	3	2	2	1	1	1	2	1	1	1
CO4	3	3	3	1	2	1	1	1	1	2	1	2
CO5	3	3	2	2	1	1	1	1	2	1	1	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2020-21 ACADEMIC YEAR: 2021-22
SEMESTER : THIRD

COURSE TITLE: MANUFACTURING PROCESSES - I		
Sub Code: 18ME33	**No of Credits =3** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks: 50**
Pre-requisites	**Elements of Mechanical Engineering**	

COURSE OBJECTIVES:

1. This course will introduce the student to the various constituent of molding sand.
2. The course is to study various molding machines and casting process.
3. This course is to study various melting furnaces and welding process.

#	CONTENTS	Hrs
UNIT-1	**MOULDING MATERIALS, PROCESSES & MACHINES**	**08**
	Introduction: Concept of manufacturing process, its importance. Classification of manufacturing processes and list different material handling methods. Introduction to casting process & steps involved. Components varieties, of produced by casting processes. Advantages & limitations of casting processes. **Patterns**: Definition, functions, materials used for pattern, various pattern allowances and their importance. Classification of patterns, BIS color coding of patterns. **Binder:** Definition, Types of binder used in molding sand. Additives: need, types of additives used and their properties. **Sand molding:** Sand, Types of base sand, requirement of base sand, molding sand mixture, ingredients for different sand mixtures. **Moulding machines:** Jolt type, Squeeze type, Jolt & Squeeze type and sand slinger. **Molding processes:** Method used for sand molding such as green sand, dry sand and skin dried moulds, sweep mold, CO2 mold, shell mold, flask less moulds, investment mould. **Cores:** Definition, need, types, method of making cores, binders used, core sand moulding, Concept of gating and risering.	
UNIT-2	**CASTING PROCESSES & MELTING FURNACES**	**08**
	Casting processes: Gravity die-casting, pressure die casting, centrifugal casting, and continuous casting processes. **Casting defects**: Causes, features and remedies. **Melting furnaces:** Classification of furnaces, Constructional features & working principle of coke fired, oil fired and gas fired pit furnace, resistance furnace, coreless induction furnace, electric arc furnace, Cupola furnace and process parameters.	
UNIT-3	**WELDING PROCESSES**	**07**
	Welding processes: Introduction, definition, principles, classification, application, advantages & limitations of welding. Arc welding: Principle, metal arc welding (MAW), flux shielded metal arc welding (FSMAW), inert gas welding (TIG & MIG). Briefing about latest welding processes. Resistance welding: Principles, seam welding, butt welding, spot welding and projection welding, friction welding, explosive welding, thermit welding.	

UNIT-4	**METALLURGICAL ASPECTS OF WELDING & INSPECTION METHODS**	**08**
	Metallurgical aspects: Structure of welds, formation of different zones during welding. Heat affected zone (HAZ), parameters affecting HAZ. Effect of carbon content on structure and properties of steel. **Inspection methods:** Methods used for inspection of casting and welding. Visual, magnetic particle, fluorescent particle, ultrasonic, radiography, eddy current, holography methods of inspection.	
UNIT-5	**MECHANICAL WORKING OF METALS**	**08**
	Introduction to metal forming processes & classification of metal forming processes. Hot working & cold working of metals. Forging: Smith forging, drop forging & press forging. Forging Equipment, Defects in forging. **Rolling:** Rolling process, Angle of bite, Types of rolling mills, Variables of rolling process, Rolling defects. **Drawing & Extrusion:** Drawing of wires, rods & pipes, Variables of drawing process. Difference between drawing & extrusion. Various types of extrusion processes. **Sheet Metal Operations:** Blanking, piercing, and punching.	

TEXT BOOKS:

1. **"Manufacturing Process-I & II",** Dr. K. Radhakrishna, Sapna Book House, 5th Revised Edition 2009.
2. **"Manufacturing & Technology**: Foundry Forming and Welding", P.N. Rao 2nd Ed, TMH, 2003.
3. **Manufacturing Science**, Amitabha Ghoshand Mallik, affiliated East West Press, 2003.
4. **Metal Casting: Principles and Practice**, T.V. Ramana Rao,Published by New Age International (P) Limited (2010)
5. **Principles of Metal Casting,** MahiSahoo **,** Sam Sahu **, McGraw Hill Education (India) Private Limited; Third edition (26 September 2014)**

REFERENCE BOOKS:

1. **"Manufacturing Technology**", Serope Kalpakjain, Steuen.R. Sechmid, Pearson Education Asia, 5th Ed. 2006.
2. **"Process and Materials of Manufacturing**", Roy A Lindberg, 4thEd. Pearson Edu. 2006.
3. **Principles of Metal Casting- Second Edition**, Heine, Richard W.; CarlR. Loper, Jr. & Philip C. Rosenthal, Published by McGraw-Hill, New York (1967)
4. **Mechanical Metallurgy Paperback,** George E. Dieter **TMH.**
5. **Metal Forming: Mechanics and Metallurgy**, Hosford,WF and Caddell,R.M, Published by Prentice Hall (1993)

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

CO1: Explain different manufacturing process, patterns, cores, moulding sand constituents, moulding process and machines.

CO2: Discuss different casting processes, defects and melting furnaces.

CO3: Understand the principle of metal arc, TIG, MIG, resistance, explosive and thermit welding processes.

CO4: Describe metallurgical aspect of welding, inspection of casting and welded components.

CO5: Understand the concepts of mechanical working of metals, forging, rolling, drawing, extrusion and sheet metal operations.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	0	1	2	0	1	3	1	1	0	1	3
CO2	1	0	1	2	0	1	3	1	1	0	1	3
CO3	1	0	1	2	0	1	3	1	1	0	1	3
CO4	1	0	1	2	0	1	3	1	1	0	1	3
CO5	1	0	1	2	0	1	3	1	1	0	1	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2020-21 ACADEMIC YEAR: 2021-22
SEMESTER : THIRD

COURSE TITLE : BASIC THERMODYNAMICS		
Sub Code: 18ME34	**No of Credits : L-T-P-SS 3:2:0:0= 4**	**No. of Contact hours/week : 3L+2T Total Number of contact hours : 65**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**
Pre-requisites	**Engineering Chemistry, Physics, Mathematics**	

COURSE OBJECTIVES:

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

#	CONTENTS	Hrs.
UNIT-1	**FUNDAMENTAL CONCEPTS, WORK & HEAT**	**9L+4T**
	Fundamental Concepts: Macroscopic and microscopic viewpoint, thermodynamic system and control volume, thermodynamic property, process and cycle, homogeneous and heterogeneous system, thermodynamic equilibrium, quasi-static process, pure substance, concept of continuum, thermostatics, units and dimensions; zeroth law of thermodynamics, temperature scales, different types of thermometers. **Work and Heat:** 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, comparison of heat and work transfer; Numerical problems.	
UNIT-2	**FIRST LAW OF THERMODYNAMICS**	**9L+4T**
	First law of a closed system undergoing a cycle (Joule's experiment) and undergoing a change of state, energy as a property of a system, forms of stored energy, specific heat at constatn volume and constant pressure, enthalpy, energy of an isolated system, PMM 1, limitations of the first law; application of first law to flow processes – control volume, steady flow process, mass and energy balance in a simple steady flow process, examples of steady flow processes - turbines, pumps, nozzles and diffusers; Numerical problems.	
UNIT-3	**SECOND LAW OF THERMODYNAMICS AND ENTROPY**	**9L+4T**
	Qualitative difference between heat and work, cyclic heat engine, energy reservoirs, kelvin-planck and clausius statement of second law of thermodynamics, PMM 2, refrigerator and heat pump, equivalence of kelvin-planck and clausius statements, reversibility and irreversibility, causes and conditions of irreversibility, carnot cycle, reversed heat engine, carnot's theorem and its corollary, absolute thermodynamic temperature scale, efficiency of the reversible heat engine, equality of ideal gas and Kelvin temperatures, types of irreversibility, numericals. Entropy - Introduction, clausius theorem, The property of entropy, T-S plot,	

	clausius inequality, entropy change in an irreversible process, entropy principle and its applications. Numerical problems.	
UNIT-4	**AVAILABILITY AND PROPERTIES OF PURE SUBSTANCE**	**9L+4T**
	Availability, Irreversibility and General Thermodynamic relations. Introduction, Availability (Exergy), Unavailable energy, Relation between increase in unavailable energy and increase in entropy. Maximum work, maximum useful work for a system and control volume, irreversibility; Pure substances: p-V diagram and p-T diagram, p-v-T surface, T-s and h-s diagram for a pure substance, quality of pure substance, steam tables – saturation state, liquid-vapour mixture, compressed liquid, charts of thermodynamic properties, measurement of steam quality – throttling calorimeter, separating and throttling carlorimeter; Numerical problems.	
UNIT-5	**IDEAL AND REAL GASES**	**9L+4T**
	Ideal gases: Ideal gas mixtures, Daltons law of partial pressures, Amagat's law of additive volumes, evaluation of properties of perfect and ideal gases, Air-Water mixtures and related properties. Real gases – Introduction, Van-der Waal's Equation of state, Van-der Waal's constants in terms of critical properties, Beattie-Bridgeman equation, Law of corresponding states, compressibility factor; compressibility chart. Difference between Ideal and real gases; Numerical problems.	

TEXT BOOKS

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

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

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

REFERENCE BOOKS

1. Applications of Thermodynamics, V. Kadambi, T R Seetharam and K B Subramanya Kumar, Wiley India Private Limited, 1st Edition, 2019

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

3. Fundamentals of Engineering thermodynamics by H . N. Shapiro & M J Moran.

e-LEARNING RESOURCES

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

DATA HAND BOOK

Thermodynamics Data Book, B T Nijaguna and B S Samaga, Sudha Publishers, 2016.

COURSE OUTCOME (CO)

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

CO1: *Explain* the concept of thermodynamic system and its interaction with surroundings; *differentiate* work and heat transfer in various quasistatic thermodynamics processes; and *solve* related numerical problems (RBTL 1, 2, 3)

CO2: *Interpret* the first law of thermodynamics applied to a thermodynamic system and a flow process; and *solve* related numerical problems (RBTL 1, 2, 3).

CO3: *Understand* the Kelvin-Planck and Clausius statements of second law of thermodynamics; *understand* the concept of entropy principle and its applications to thermodynamic processes; *summarize* thermodynamic relations; and *solve* related numerical problems (RBTL 1, 2, 3).
CO4: *Understand* the concept of availability and irreversibility; *understand* various thermodynamic property diagrams for a pure substance; *use* the steam tables; (RBTL 1, 2, 3)
CO5: D*iscuss* ideal and real gases; and *solve* related numerical problems (RBTL 1, 2, 3)
(RBTL: Revised Bloom's Taxonomy Levels; 1 – Remembering, 2 – Understanding, 3 – Applying, 4 - Analyzing, 5 - Evaluating, 6 - Creating)

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	0	0	0	2	1	1	1	0	1
CO2	3	3	2	0	0	0	2	1	1	1	0	1
CO3	3	3	3	0	0	0	2	1	1	1	0	1
CO4	3	3	3	0	0	0	2	1	1	1	0	1
CO5	3	3	3	0	0	0	2	1	1	1	0	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2020-21 ACADEMIC YEAR: 2021-22
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**	**SEE 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**	**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**	**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**	**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 : 2020-21 ACADEMIC YEAR: 2021-22
SEMESTER : THIRD

COURSE TITLE : MANUFACTURING PROCESSES LABORATORY - I		
Sub Code: 18MEL36	**No of Credits: 01** **L-T-P-SS :: 0:0:2:0 = 01**	**No. of practical hours/week: 02**
Exam Duration : 03 hours	**CIE Marks: 50**	**SEE Marks: 50**
Pre-requisites	**EME, Manufacturing Processes I**	

COURSE OBJECTIVES:

1) This course will give the student a knowledge of testing foundry sand.
2) It also focuses on sand mold preparation with and without patterns.

PARTS	**CONTENTS**	**Hrs**
PART - A	**SAND TESTING**	**10**
	1. To determine compression strength of a given molding sand specimen using universal sand testing machine. 2. To determine shear strength of a given molding sand specimen using universal sand testing machine. 3. To determine tensile strength of a given molding sand specimen using universal sand testing machine. 3. Conduct a permeability test on a given sand specimen to determine permeability of sand using permeability meter. 4. To determine grain fineness number of a given sand using sieve shaker. 5. To determine clay content in a given sand mixture using clay stirrer. 6. To determine hardness of a mold using hot air oven. 7. To determine hardness of a core using hot air oven.	
PART - B	**FOUNDRY**	**16**
	Use of foundry tools. (i) Preparation of different shape of molds without using a patterns. (ii) Preparation of different shape of molds with using a patterns. (iii) 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)	**MAXIMUM MARKS**
One sand testing experiment from **PART A**	20
One foundry model from **PART B**	20
Viva – Voce	10
TOTAL	**50**

ADMISSION YEAR : 2020-21 ACADEMIC YEAR: 2021-22
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**	**SEE 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)	**MAX MARKS**
ONE question from Part A	**25**
ONE question from Part B	**15**
Viva – Voce	**10**
TOTAL	**50**

ADMISSION YEAR : 2020-21 ACADEMIC YEAR: 2021-22
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**	**SEE Marks: 50**
Pre-requisites	**EME, Manufacturing Processes**	

COURSE OBJECTIVES:

1. To give an introduction to fitting tools and preparation of different fitting models.
2. To forge a model involving various forging operations.

#	CONTENTS	Hrs.
PART A	**FITTING**	**10**
	• Demonstration of different fitting tools and operations. • Preparation of a minimum two different fitting models involving various operations.	
PART B	**FORGING**	**16**
	• Demonstration of different forging tools and operations. Forging models preparation • Calculation of length of the raw material required to prepare a given forging 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)

CONTINUOUS INTERNAL EVALUATION (CIE)	
LABORATORY 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**
LABORATORY INTERNALS 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	**20 MARKS**
GRAND TOTAL (TOTAL – 1 + TOTAL – 2)	**50 MARKS**

SCHEME OF EXAMINATION (SEE)	**MAX MARKS**
One fitting model from **PART A**	**15**
One forging model from **PART B**	**25**
Viva – Voce	**10**
TOTAL	**50**

ADMISSION YEAR : 2020-21 ACADEMIC YEAR: 2021-22
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**	**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**	**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**	**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**	**09**

	Measurement: Definition, significance, accuracy, Resolution precision, calibration, threshold, sensitivity, hysteresis, 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**	**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 : 2020-21 ACADEMIC YEAR: 2021-22
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**	**SEE Marks : 50**
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 meta 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**	**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**	**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**	**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**	**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**

	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.										

ADMISSION YEAR : 2020-21 ACADEMIC YEAR: 2021-22
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	**CIE Marks: 50**	**SEE Marks: 50**
Pre-requisites	**Manufacturing Processes - I**	

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	**08**
	Single point cutting tool nomenclature, geometry. Mechanics of Chip Formation, Types of Chips. Orthogonal cutting and oblique cutting, Causes of oblique cutting, ISO standards for cutting tools. 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**	**08**
	Desired properties and types of cutting tool materials – HSS, carbides, coated carbides, ceramics. Cutting fluids. Desired properties, types and their application, 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	**07**
	Lathes, Shaping, Planing And Slotting Machines: Classification, working principle, Different operations, work holding and tool holding devices on lathes, turret and capstan lathe, shaping machine, planing machine and slotting machines, mechanism, types of tools used. General and periodic maintenance of a centre lathe. Simple problems on machining time calculations.	
UNIT-4	**DRILLING, MILLING, HOBBING, GRINDING AND BROACHING MACHINE**S	**09**
	Drilling And Milling Machines: Classification, working principle, 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.	
UNIT-5	**FINISHING PROCESSES**	**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**, AmitabhaGhosh and Mallik, affiliated East West Press, 2003.
2. **Fundamentals of Metal Machining and Machine Tools,** G.Boothroyd, McGraw Hill, 2000
3. M C Shaw, Metal Cutting Principles, Oxford and IBH Publications, New Delhi (1969)

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 : 2020-21 ACADEMIC YEAR: 2021-22
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**	**SEE Marks: 50**
Pre-requisites	**Fluid mechanics, Basic 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**	**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,	
UNIT-2	**GAS TURBINE CYCLES AND JET PROPULSION**	**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**	**9L+4T**
	Introduction; 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	
UNIT-5	**REFRIGERATION CYCLES AND PSYCHROMETRY**	**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,	

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 : 2020-21 ACADEMIC YEAR: 2021-22
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**	**SEE Marks: 50**
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**	**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)**	**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**	**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**	**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 : 2020-21 ACADEMIC YEAR: 2021-22
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**	**SEE Marks: 50**
Pre-requisites	**EME, Manufacturing Processes II**	

COURSE OBJECTIVES:

1. To use tools and produce simple models incorporating all the operations on a turning machine i.e., lathe
2. To understand indexing and cut gear teeth using a horizontal milling machine

#	CONTENTS	Hrs.
PART A	**LATHE** Identify different turning tools, their parts, material and their use. Preparation of four models using a turning machine (lathe) involving following operations: • 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** Identify milling tools, their parts, material and their use. Cutting of gear teeth on a given gear blank using milling machine after proper calculation on gear – 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: Get conversant with the lathe and prepare models.

CO2: Calculate the number of gear teeth that can be cut on the given blank 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)

CONTINUOUS INTERNAL EVALUATION (CIE)	
LABORATORY 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**
LABORATORY INTERNALS 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	**20 MARKS**
GRAND TOTAL (TOTAL – 1 + TOTAL – 2)	**50 MARKS**

SCHEME OF SEMESTER END EXAMINATION (SEE)	MAXIMUM MARKS
One model from **PART A**	30
One model from **PART B**	10
Viva – Voce	10
TOTAL	**50**

ADMISSION YEAR : 2020-21 ACADEMIC YEAR: 2021-22
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	**Mechanical Measurements**	

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)	**MAX MARKS**
One experiment from PART A	**15**
One experiment from PART B	**25**
Viva – Voce	**10**
TOTAL	**50**

Dr. Ambedkar Institute of Technology, Bengaluru-560 056
SCHEME OF TEACHING AND EXAMINATION from Academic Year 2021-22
B.E MECHANICAL ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

V SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	HS	18HS51/52	Management & Entrepreneurship / Intellectual Property Rights	Hu	3	-	--	03	50	50	100	3
2	PC	18ME51	Design of Machine Elements - I	ME	4	0	--	03	50	50	100	4
3	PC	18ME52	Dynamics of Machines	ME	3	0	--	03	50	50	100	3
4	PC	18ME53	Turbo machines	ME	2	2	--	03	50	50	100	3
5	PC	18ME54	Computer Aided Design and Manufacturing	ME	4	0	--	03	50	50	100	4
6	PE	18XX55X	Professional Elective -1	ME	3	0	--	03	50	50	100	3
7	OE	18ME56X	Open Elective -A		3	--	--	03	50	50	100	3
8	PC	18MEL57	Computer Aided Manufacturing Laboratory	ME	--	--	2	03	50	50	100	1
9	PC	18MEL58	Fuel Testing and Internal Combustion Engines Laboratory	ME	--	0	2	03	50	50	100	1
TOTAL					**22**	**2**	**4**	**27**	**450**	**450**	**900**	**25**

10	HS	18HS55	Placement Training	Hu	02	--	--	03	50	-	50	PP/ NP
Note: Hu: Humanities, PC: Professional Core, MC: Mandatory Course												

Course code	**Professional Electives - 1**	**OPEN ELECTIVE –A**
18ME551	Engineering Economics	Students can select any one of the open electives (Please refer to consolidated list of Dr AIT for open electives) offered by any Department. Selection of an open elective is not allowed provided, • The candidate has studied the same course during the previous semesters of the programme. • The syllabus content of open elective is similar to that of Departmental core courses or professional electives. • A similar course, under any category, is prescribed in the higher semesters of the programme. Registration to electives shall be documented under the guidance of Programme Coordinator / Mentor.
18ME552	Composite Materials and Manufacturing	
18ME553	Automobile Engineering	
18ME554	Mechatronics and Microprocessor	
18ME555	Principles of Metal Forming	
18ME556	Experimental Stress Analysis	
	OPEN ELECTIVE – A	
18XX56X		

Dr. Ambedkar Institute of Technology, Bengaluru-560 056
SCHEME OF TEACHING AND EXAMINATION from Academic Year 2021-22
B.E MECHANICAL ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

VI SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	HS	18HS61/62	Management & Entrepreneurship / Intellectual Property Rights	Hu	3	--	--	03	50	50	100	3
2	PC	18ME61	Design of Machine Elements - II	ME	3	2	--	03	50	50	100	4
3	PC	18ME62	Heat Transfer	ME	3	2	--	03	50	50	100	4
4	PC	18ME63	Mechanical Vibrations	ME	2	2	--	03	50	50	100	3
5	PE	18ME64X	Professional Elective -2	ME	3	0	--	03	50	50	100	3
6	OE	18XX65X	Open Elective -B		3	--	--	03	50	50	100	3
7	PC	18MEL66	Fluid Mechanics and Machines Laboratory	ME	--	--	2	03	50	50	100	1
8	PC	18MEL67	Heat Transfer Laboratory	ME	--	0	2	03	50	50	100	1
9	MP	18MEMP68	Mini-project	ME				03	50	50	100	2
10	INT	18MEI69	Industry Internship	(To be carried out during the intervening vacations of VI / VII semesters)				--				
			TOTAL		**17**	**6**	**4**	**27**	**450**	**450**	**900**	**24**

10	HS	18HS66	Placement Training	Hu	02	--	--	03	50	-	50	PP/NP

Note: PC: Professional core, PE: Professional Elective, OE: Open Elective, MP: Mini-project, INT: Internship.

Internship: All the students admitted to III year of BE/B. Tech have to undergo mandatory internship of 4 weeks during the vacations of VI and VII semesters and /or VII and VIII semesters. A University examination will be conducted during VIII semester and prescribed credit are added to VIII semester. Internship is considered as a head of passing and is considered for the award of degree. Those, who do not take-up/complete the internship will be declared as failed and have to complete during subsequent University examination after satisfy the internship requirements.

Course code	**Professional Electives - 2**	**OPEN ELECTIVE –B**
18ME641	Inspection and Quality Control	Students can select any one of the open electives (Please refer to consolidated list of Dr AIT for open electives) offered by any Department. Selection of an open elective is not allowed provided, • The candidate has studied the same course during the previous semesters of the programme. • The syllabus content of open elective is similar to that of Departmental core courses or professional electives. • A similar course, under any category, is prescribed in the higher semesters of the programme. Registration to electives shall be documented under the guidance of Programme Coordinator / Mentor.
18ME642	Advanced Welding Processes	
18ME643	Internal Combustion Engines	
18ME644	Production and Operations Management	
18ME645	Finite Element Methods	
18ME646	Fluid Power Control Systems	
	OPEN ELECTIVE – B	
18XX65X		

ADMISSION YEAR : 2019-20 **ACADEMIC YEAR: 2021-22**
SEMESTER : FIFTH

COURSE TITLE : DESIGN OF MACHINE ELEMENTS – I		
Sub Code: 18ME51	**No of Credits =04** **L-T-P-SS::4:0:0:0**	**No. of lecture hours/week : 04** **Total Number of Lecture hours : 52**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**
Pre-requisites	**Mechanics of Materials, Material science and metallurgy**	

COURSE OBJECTIVES:

1. To study basic principles of machine design
2. To acquaint with the concepts of strength design related to various components.
3. To familiarize usage of design data books & various codes of practice.
4. To make conversant with preparation of working design drawings

#	CONTENTS	Hrs
UNIT-1	**INTRODUCTION TO MACHINE DESIGN**	**10**
	Introduction to machine design, Classification, Phase/steps in Machine design process. Design Considerations, Design Method and mechanical Properties and IS coding of various materials, Selection of material from properties and economic aspects. Manufacturing Considerations in Design: Standardization, Interchangeability, limits, fits tolerances and surface roughness, BIS codes, Design consideration for cast, forged and machined parts. Codes and standards, Stress-strain diagrams, Stress analysis, Definitions: normal, shear, biaxial and tri axial stresses, Stress tensor, Principal and Shear Stresses and their directions.	
UNIT-2	**DESIGN FOR STATIC STRENGTH & STRESS CONCENTRATION**	**10**
	DESIGN FOR STATIC STRENGTH: Static loads and factor of safety, Theories of failure: Maximum normal and shear stress theories, Maximum strain theory, Strain and Distortion energy theories. Failure of brittle and ductile materials. **STRESS CONCENTRATION:** Definition, Reason for occurrence, Methods to reduce, Stress concentration factor, charts and static loads, compound stress concentration factors, Design of stress concentrated members under various loads and Numerical problems.	
UNIT-3	**DESIGN FOR FATIGUE STRENGTH & IMPACT STRENGTH**	**10**
	DESIGN FOR FATIGUE STRENGTH: Introduction- S-N Diagram, Low and High cycle fatigues, Endurance limit, fatigue failure prevention. Modifying factors: Load, size, surface, causes for SEF and effects of SEF, Fluctuating stresses, Soderberg and Goodman, Gurber relation, stresses due to combined loading, cumulative fatigue damage. Problems on design of members for finite & infinite life subjected to individual & combined loading. Cumulative damage in fatigue. **IMPACT STRENGTH:** Introduction, Impact stresses due to axial, bending and torsional loads, effect of inertia. Numerical problems**.**	
UNIT-4	**DESIGN OF SHAFTS, KEYS & COUPLINGS**	**10**
	DESIGN OF SHAFTS: Types, Design of solid & hollow shaft on strength and rigidity basis with steady loading subjected to pure torsion with steady loading, Design of shafts carrying pulleys & gears (Combined loading). ASME codes for power transmission shafting, shafts under fluctuating loads and combined loads and Numerical problems. **KEYS:** Types of Keys and their selection based on shafting condition, key ways, splines**.**	

	SHAFT COUPLINGS: Introduction, classification, advantages, and applications of Couplings: design of rigid and flexible couplings, Flange coupling, Bush and Pin type coupling and Oldham's coupling and Numerical problems.	
UNIT-5	**RIVETED, WELDED AND BOLTED JOINTS**	**12**
	PRESSURE VESSELS: Introduction, Purpose, Unfired Pressure Vessels at Hydroelectric Facilities, Inspection of Unfired Pressure Vessels, Frequency of Inspections, Inspector qualifications, Pre-Inspection Activities, Inspection Procedure, External Inspection, Thickness Survey, Stress Analysis, Internal Inspection, Non Destructive Testing, Pressure Testing. **RIVETED JOINTS**: Types, rivet materials, Modes of failures of riveted joints, Strength Equations – efficiency of riveted joints, Joint Efficiency, Boiler Joints, Lozenge Joints, Riveted Brackets, Eccentrically riveted joints and Numerical problems. **WELDED JOINTS:** Types, Strength of butt and fillet welds, eccentrically loaded welded joints and Numerical problems. **BOLTED JOINTS:** Design of bolts with pre-stresses – Design of joints under eccentric loading	

TEXT BOOKS:

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

DESIGN DATA HANDBOOK:

1. Design Data Hand Book, K. Lingaiah, Mc Graw Hill, 2nd Ed.
2. Data Hand Book, K. Mahadevan and Balaveera Reddy, CBS Publication
3. Design Data Hand Book, H.G. Patil, Shri Shashi Prakashan, Belgaum.

REFERENCE BOOKS:

1. **Machine Design,** Robert L. Norton, Pearson Education Asia, 2001.
2. Design of Machine Elements, M. F. Spotts, T. E. Shoup, L. E. Hornberger, S. R. Jayram and C. V. Venkatesh, Pearson Education, 2006.
3. Machine Design, Hall, Holowenko, Laughlin (Schaum's Outlines series) Adapted by S.K. Somani, TMH, New Delhi, Special Indian Edition, 2008.
4. Fundamentals of Machine Component Design, Robert C. Juvinall and Kurt M Marshek, Wiley India Pvt. Ltd., New Delhi, 3rd Edition, 2007.
5. Fundamentals of Machine Elements - Hawrock, Jacobson Mcgraw Hill
6. Machine Design - Patel, Pandya, Sikh, Vol. - I & II, C.
7. Fundamentals of Machine Elements B.J. Hamrock, and S.R. Schmid TMH.
8. The Mechanical Design Process. D.G. Ullman, TMH, New Delhi, 2008.

COURSE OUTCOMES: On completion of the course, students will be able to:

CO1: Demonstrate understanding of various design considerations

CO2: Apply basic principles of machine design

CO3: Design machine elements on the basis of strength concept

CO4: Use design data books and various standard codes of practices and acquire skill in preparing production drawings pertaining to various designs.

CO5: Successfully design machine components for suitable applications.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	2	2	3	2	3	1	3	3
CO2	2	3	3	2	3	3	3	1	2	3	3	2
CO3	3	3	2	3	3	3	3	1	3	2	3	2
CO4	3	3	2	3	3	2	3	2	1	2	3	3
CO5	3	3	3	3	2	2	3	2	3	1	3	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										
3. Design Data Hand Book is permitted										

ADMISSION YEAR : 2019-20 ACADEMIC YEAR: 2021-22
SEMESTER : FIFTH

COURSE TITLE : DYNAMICS OF MACHINES		
Sub Code: 18ME52	**No of Credits =03** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**
Pre-requisites	**KOM**	

COURSE OBJECTIVES:

1. Draw and analyze free body diagram for multiple forces applied on static members of four bar chain and slider mechanism.
2. Design the size of the flywheel for the excess energy storage and retrieval.
3. The terms slip and creep in belt drives.
4. Determine the value of balancing mass for the system.
5. Define sensitivity, isochronous, hunting, controlling force with respect to governors.
6. Analyses the effect of gyro on automobile, ship, Aeroplanes.

UNITS	CONTENTS	Hrs
UNIT-1	**STATIC FORCE ANALYSIS**	**08**
	Introduction, Static equilibrium, Equilibrium of two and three force members. Members with two forces and torque, Free body diagrams, Static force analysis of simple mechanisms. Principle of virtual work, Numericals.	
UNIT-2	**DYNAMIC FORCE ANALYSIS**	**07**
	Dynamic force analysis, motion and Inertia: Alembert's principle, Inertia force and inertia torque, Inertia forces on a four bar mechanism, Numericals.	
UNIT-3	**FRICTION & BELT DRIVES**	**08**
	Friction: Introduction, Types of Friction, Friction between lubricated and Unlubricated surfaces, Coefficient of friction Laws of Static Friction, Laws of Kinetic or Dynamic Friction, Laws of Solid Friction, Friction of Pivot and Conical Bearings (Flat and Conical), Numerical Problems **Belt dives:** Initial tension in the belt, ratio of belt tensions, Effect of Centrifugal tension, power transmitted by Belt thickness and width calculations, V-Belts, Rope Drives (circular belts) Numericals.	
UNIT-4	**BALANCING OF ROTATING and RECIPROCATING MASSES**	**08**
	Balancing Of Rotating Masses: Static and dynamic balancing. Balancing of single rotating mass in same plane and in different planes. Balancing of several rotating masses in same plane and in different planes, Numericals. **Balancing Of Reciprocating Masses:** Inertia effect of crank and connecting rod, single cylinder engine, balancing in multi cylinder-inline engine (primary & secondary forces), V-type engine; Numericals.	
UNIT-5	**GOVERNORS & GYROSCOPES**	**08**
	Governors: Types of governors; force analysis of Porter and Hartnell governors - Controlling force, stability, sensitiveness, isochronism, effort and power, Numericals. **Gyroscopes:** Vectorial representation of angular motion, gyroscopic couple. Effect of gyroscopic couple on the movement of plane disc, aero plane, stability of two wheeler and four wheeler taking a turn, Numericals.	

TEXT BOOKS:

1. Theory of Machines, Rattan S.S. Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition, 2009.

2. Theory of Machines, Sadhu Singh, Pearson Education. 2nd edition. 2007.

3. Theory of Machines – R.S. Khurmi & J. K. Gupta, S. Chand Publications, Reprint – 2012.

REFERENCE BOOKS:

1. Theory of Machines & Mechanisms, J.J. Uicker, G.R. Pennock, J.E. Shigley. Oxford 3rd edition. 2009

2. Mechanism and Machine Theory, A.G. Ambekar PHI, 2007.

COURSE OUTCOMES: On completion of the course, students will be able to:

CO1: Illustrate basic concept of static forces of equilibrium in a mechanism.

CO2: Illustrate basic concept of dynamic forces of equilibrium in a mechanism and design a flywheel

CO3: Characterize the operation of bearings and belt drives and design them for power transmission.

CO4: Analyze and understand concept of static and dynamic balancing of rotating and reciprocating masses in engine.

CO5: Analyze and understand working Principles of different types of governors and Gyroscopic effects on the mechanical systems

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	1	2	2	2	1	2	3	2	1
CO2	3	2	2	1	2	2	2	1	2	3	2	1
CO3	3	2	2	1	2	2	2	1	2	3	2	1
CO4	3	2	2	1	2	2	2	1	2	3	2	1
CO5	3	2	2	1	2	2	2	1	2	3	2	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2019-20 ACADEMIC YEAR: 2021-22
SEMESTER : FIFTH

COURSE TITLE : TURBOMACHINES		
Sub Code: 18ME53	**No of Credits : L-T-P-SS 2:2:0:0 =3**	**No. of lecture hours/week : 04 Total Number of Lecture hours : 52**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 100**
Pre-requisites	**Basic Thermodynamics, Fluid Mechanics**	

COURSE OBJECTIVES :

1. To outline the working principle of turbo machines with examples and classify turbomachines and describe the energy transfer mechanism of turbo machines.
2. To understand the thermodynamics of flow and apply dimensional analysis and similarity laws for conducting model tests.
3. To explain the functioning of radial flow and axial flow turbo machines such as centrifugal pumps, compressors, steam, gas and hydraulic turbines
4. To demonstrate the effect of important variables affecting the output of turbo machines.
5. To analyze a given problem, apply the fundamental knowledge to solve the problems.
6. To estimate and evaluate unknown parameters and predict the performance of turbo machines.

#	CONTENTS	Hrs.
UNIT-1	**INTRODUCTION AND DIMENSIONAL ANALYSIS**	**10L+2T**
	Introduction: Definition of a turbo machine; parts of a turbo machine; comparison with positive displacement machine; classification of Turbomachines. **Thermodynamics of fluid flow:** Application of first and second law of thermodynamics to turbo machines; Efficiencies of turbo machines; Static and Stagnation states; Overall isentropic efficiency, stage efficiency (their comparison) and polytropic efficiency for both compression and expansion processes; Reheat factor for expansion process; Simple numerical problems on stage efficiency and polytropic efficiency. **Dimensional Analysis:** Introduction, derived quantities, dimensions of physical quantities, dimensional homogeneity, Rayleigh's method, Buckingham □ theorem, dimensionless numbers, and similitude, types of similitude, dimensional analysis and similarity studies. Numerical problems.	
UNIT-2	**GENERAL ANALYSIS OF RADIAL AND AXIAL FLOW TURBOMACHINES**	**8L+2T**
	Energy transfer in a turbo machine - Euler turbine equation; alternate form of Euler turbine equation (components of energy transfer); degree of reaction, utilization factor and relationship between them. **General analysis of radial flow turbo machines (turbines and pumps)** - Effect of blade discharge angle on their performance; Theoretical head-capacity relationship; Numerical problems. **General analysis of axial flow turbines** – utilization factor, degree of reaction, relationship between utilization factor and blade speed ratio; Maximum utilization factor and optimum blade speed ratio for impulse and reaction axial flow turbines; General analysis of axial flow compressors and pumps – general expression for energy transfer and degree of reaction; Numerical problems.	
UNIT-3	**STEAM TURBINES**	**8L+2T**

	Introduction; Different efficiencies; Analysis of single stage impulse (De Laval) turbine; Impulse staging and need for compounding; Analysis of velocity compounded impulse (Curtis) turbine; Analysis of Impulse-reaction (Rateau) turbine; Reheat factor for multi stage turbine; Numerical problems.	
UNIT-4	**HYDRAULIC TURBINES**	**8L+2T**
	Introduction; Classification; Different heads and efficiencies; Pelton turbine-velocity triangles; Francis turbine-velocity triangles, runner shapes for different blade speeds; function of a draft tube, types of draft tube; Kaplan and Propeller turbines – velocity triangles and analysis; Related numerical problems; Specific speed and its significance; Unit quantities and their uses; Characteristic curves of hydraulic turbines; Numerical Problems.	
UNIT-5	**CENTRIFUGAL PUMPS AND COMPRESSORS**	**8L+2T**
	Centrifugal pumps –Introduction, Main parts of a centrifugal pump; Work done; Definitions of heads and efficiencies; minimum speed for starting; Multistage centrifugal pump; Specific speed; Priming; Characteristic curves; Cavitation; Thoma's cavitation factor; Maximum suction lift; Net positive suction head; Related numerical problems: Centrifugal compressors-Introduction; Work done; Overall pressure ratio developed; Pressure ratio in terms of ϕ_s, ϕ_p, ϕ_w; Compressibility and pre-whirl; Diffuser design; Surging; Numerical problems.	

TEXT BOOKS

1. A Textbook of Turbo Machines, Dr M S Govindegowda and Dr A M Nagaraja, 8th Edition, M M Publishers, 2014

2. Turbo Machines, Dr. N. Krishnamurthy, Sunstar Publisher, 2nd Edition, 2015.

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

REFERENCE BOOKS

1. An introduction to energy conversion, Vol. III – Turbomachinery, V. Kadambi and Manohar Prasad, 2nd Edition, New Age International Publishers (P) Limited, 2011.

2. Principles of turbomachinery, D. G. Shepherd, MacMillan Company, 1964.

4. Turbomachines, B.U. Pai, Wiley Precise Textbook Series, 2014.

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										
3. Each full question shall have a maximum of 3 sub-divisions.										

COURSE OUTCOME (CO): After the completion of the course, students will be able to:
CO1: *Explain* the fundamentals of energy transfer in turbo machines with the application of first and second laws of thermodynamics; *Understand* the dimensional analysis and model studies applied to turbomachines; and *solve* related numerical problems (RBTL 1, 2, 3)
CO2: *Analyse* the radial flow and axial flow turbines and *solve* related numerical problems (RBTL 1, 2, 3).
CO3: *Classify* and *analyse* the various types of steam turbines and *solve* related numerical problems (RBTL 1, 2, 3).
CO4: *Classify* and *analyse* the various types of hydraulic turbines and *solve* related numerical problems (RBTL 1, 2, 3).
CO5: *Classify* and *analyse* the various types of centrifugal pumps and compressors and *solve* related numerical problems (RBTL 1, 2, 3)
(RBTL: Revised Bloom's Taxonomy Levels; 1 – Remembering, 2 – Understanding, 3 – Applying, 4 - Analyzing, 5 - Evaluating, 6 - Creating)

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	2	1	1	1	1	1	1	1
CO2	3	3	3	1	2	1	1	1	1	2	1	1
CO3	3	3	2	1	1	1	1	1	1	2	1	1
CO4	3	3	3	1	2	1	1	1	1	2	1	1
CO5	3	3	2	1	2	1	1	1	1	3	1	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

ADMISSION YEAR : 2019-20 ACADEMIC YEAR: 2021-22
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**	**SEE Marks : 50**
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**	**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. Automation, Types of Automation, Benefits of Automation, Levels of Automation. 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**	**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**	**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**	**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	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.
4. **Automation, Production Systems and Computer Integrated Manufacturing** by Mikell P Groover, 4th Edition, 2015, Pearson Education INC.

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 : 2019-20 ACADEMIC YEAR: 2021-22
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**	**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**	**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**	**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**	**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**	**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 : 2019-20 ACADEMIC YEAR: 2021-22
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**	**SEE Marks : 50**

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**	**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 in aerospace, automotive, medical, sports, marine industry.	
UNIT-2	**PROCESSING OF POLYMER MATRIX COMPOSITES**	**08**
	Polymer matrix resins – Thermosetting resins, thermoplastic resins – Reinforcement fibres – Rovings – Woven fabrics – Non woven random mats – various types of fibres. Advantages and Limitations of PMC's 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**	**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, Recycling of Metal Matrix Composites	
UNIT-4	**PROCESSING OF CERAMIC MATRIX COMPOSITES**	**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**	**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. **Nanocomposites:** Polymer Nano Composites – Types, Nano reinforcements, Applications, Metal Matrix Nano Composites – Types, Nano reinforcements, Applications, Ceramic Nano Composites - Types, Nano reinforcements, Applications	

	3D Printing of Composites : Introduction to 3D printing, 3D Printing of Polymer and Metal Matrix Composites, Applications of 3D Printed composites	

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 Processing, 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: Knowledge about composites and its applications
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: Knowledge on the recent advances in composites

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 : 2019-20 ACADEMIC YEAR: 2021-22
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**	**SEE Marks : 50**
Pre-requisites	**EME, BTD, ATD**	

COURSE OBJECTIVES:

1. To describe the basic systems and components of Automobiles and to analyze Engines, other power generation modes and its allied mechanisms.
2. To emphasize on Fuel characteristics and Fuel flow systems and to explain combustion phenomena and ignition systems.
3. To demonstrate Power transmission & Steering mechanisms, Suspension and braking systems.
4. To define super and Turbo charging, explain the body constructional details, different of emission controlling methods and standards.
5. To emphasize Electrochemical energy converters (fuel cells)
6. To define smart materials and devices that compose sensors,

Unit	**CONTENTS**	**Hrs.**
UNIT-1	**ENGINE COMPONENTS, COOLING & LUBRICATION SYSTEMS**	**08**
	Spark Ignition (SI) & compression Ignition (CI) engines, cylinder arrangements and their relative merits, liners, piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve and port timing diagrams, cooling requirements, methods of cooling, thermostat valves, different lubrication arrangements. **Fuels, Fuel Supply Systems for SI and CI Engines:** Conventional fuels, alternative fuels, normal and abnormal combustion, cetane and octane numbers. 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	**FUEL MIXTURE REQUIREMENTS FOR SI ENGINE**	**07**
	Types of carburetors, single point and multi point fuel injection systems, fuel transfer pumps, filters, injection pumps and injectors. **Superchargers and turbochargers:** Naturally aspirated engines, forced induction, types of superchargers, turbocharger construction and operation, **Smart Materials, Structures:** smart materials and devices that compose sensors, actuators and structures for automotive applications; Electrified automotive transportation for the twenty-first century, Industrial and policy background.	
UNIT-3	**IGNITION SYSTEMS, POWER TRAINS and GEAR BOX**	**07**
	Ignition Systems: Battery, magneto, Electronic and automatic ignition systems. **Power trains:** General arrangement of clutch, principle of friction clutches, torque transmitted, constructional details, fluid flywheel, and single plate, multi-plate and centrifugal clutches.	

	Gearbox: Necessity for gear ratios in transmission, synchromesh gear boxes, principle of automatic transmission, calculation of gear ratios. Battery Electric Vehicles (BEVs), Electric Motors for Vehicle Applications, Batteries and energy storage, Charging stations.	
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, 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, air-aspirator system, catalytic converter, emission standards- euro and bharath norms.	

TEXT BOOKS

1. **Automotive mechanics,** William H Crouse & Donald L Anglin, 10th Ed.TMH 2007
2. **Automobile Engineering**, Vol I and II, Kirpal Singh, 2002.
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. To emphasize electrochemical energy converters (fuel cells)

CO2: Understand the driving wheel systems, to know propeller shaft, universal joints, steering mechanism and suspension systems. Battery Electric Vehicles (BEVs), Electric Motors for Vehicle Applications,

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	1	0	0	2	2	2	2	2	0	3
CO2	3	2	1	0	0	2	2	2	2	2	0	3
CO3	3	2	1	0	0	2	2	2	2	2	0	3
CO4	3	2	1	0	0	2	2	2	2	2	0	3
CO5	3	2	1	0	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 : 2019-20 ACADEMIC YEAR: 2021-22
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**	**SEE Marks : 50**
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**	**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**	**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**	**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**	**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**	**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. Nitaigour Premchand Mahadik, "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: To understand the basic concepts of synergy between mechanical and electronic engineering concepts

CO2: To study various fundamental sensors required in automotive, aircraft etc used in all modes of transportation

CO3: To study the miniature electrical motors required in operation various mechanical machine components

CO4: To control the flow of current in required direction used in many applications

CO5: To write the architecture of various microprocessor which is applied in computational machine

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 : 2019-20 ACADEMIC YEAR: 2021-22
SEMESTER : FIFTH

COURSE TITLE : PRINCIPLES OF METAL FORMING (PROFESSIONAL ELECTIVE - 1)		
Sub Code: 18ME555	**No of Credits =03** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 100**
Pre-requisites	**Metallurgy, MOM, Manufacturing Processes**	

COURSE OBJECTIVES

1. Express and analyze the concept of different metal forming process, concepts of stress and Strain and its elastic relationships.
2. Express and analyze the concept of Plasticity, flow curve, yield criteria, plastic stress-strain relationship and effects of various parameters on flow properties.
3. Analyze and demonstrate hot and cold metal working, metallurgical consideration in metal working -forging and rolling process.
4. Analyze and demonstrate extrusion process.
5. Analyze and demonstrate sheet metal forming and powder metallurgy.

UNIT	**CONTENTS**	**Hrs.**
UNIT-1		**08**
	Introduction to metal Forming, classification of metal working process, behaviour of materials and its failure. Concept of stress-strain, description and state of stress in 3 dimension, description of strain, hydrostatic and deviator components of stress and strain. Elastic stress-strain relationships.	
UNIT-2		**08**
	Introduction to theory of plasticity and flow curve, true stress and true strain, yield criteria for ductile materials, plastic stress-strain relationships. Measure of yielding and ductility in tensile testing, instability in tension, strain rate and temperature effects on flow properties, influence of parameters on flow properties.	
UNIT-3		**08**
	Mechanics of metal working and analysis method, determination of flow stress in metal working, hot working and cold working, metallurgical consideration in metal forming. introduction and classification of forging process, forging in plane strain, Introduction and classification of rolling process, analysis of rolling load calculation	
UNIT-4	(**For Online class**)	**08**
	Introduction and classification of extrusion process, analysis of extrusion process, extrusion of tubes and pipes, introduction of rod and wire drawing, analysis of wire and tube drawing process.	
UNIT-5	Introduction and classification of sheet metal working operations and powder metallurgy forming.	**07**

Course Outcomes: At the end of the course, student will able to:
CO1: Define Metal forming process and classification, concepts of stress-strain and its elastic relationships.
CO2: Apply engineering concepts of Plastic deformation in Metals and its flow characteristics with certain phenomenon.
CO3: Describe and differentiate between Hot and cold forming, its associated metallurgical behavior and working principles of Forging and Rolling process.
CO4: Explain principles of Extrusion, classification and Wire drawing principle
CO5: Describe the concepts of Sheet Metal forming, its operations and its application. Also Powder metallurgy and its application

TEXT BOOKS:

1. Mechanical metallurgy (SI Units), G.E.Dieter, McGraw hill Pub-2001.
2. Ghosh A. Mallik A K Manufacturing science, Affiliated East-West press Pvt Ltd
3. Rowe, Geoffrey W. An Introduction to the principles of Metal working, TMH

REFERENCE BOOKS:

1. Materials & Process in Manufacturing – E.Paul, Degramo, J.T.Black, Ranold, A.K.Prentice-hall of India 2002
2. Fundamentals of Manufacturing Processes by Lal G K, Narosa
3. Textbook of Production Engineering by P. C. Sharma, S Chand & Company Ltd

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	3	0	0	0	0	0	0	0	0	0	0
CO2	2	3	0	0	0	0	0	0	0	0	0	0
CO3	2	3	3	3	3	0	0	0	1	1	1	1
CO4	2	3	3	3	3	0	0	0	1	1	1	1
Strength correlation: 3-strongly correlated,2-moderately correlated, 1-weakly correlated 0-Not correlated												

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: 2021-22
SEMESTER : FIFTH

COURSE TITLE : EXPERIMENTAL STRESS ANALYSIS (PROFESSIONAL ELECTIVE – 1)		
Sub Code: 18ME556	**No of Credits : L-T-P-SS 3:0:0:0 =3**	**No. of lecture hours/week : 03 Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**
Pre-requisites	**Mechanics of Materials**	

COURSE OBJECTIVES:

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

. #	CONTENTS	Hrs.
UNIT-1	**PHOTOELASTICITY**	**07**
	Nature of light, Wave theory of light - optical interference, stress optic law – effect of stressed model in plane and circular polariscopes, Analysis of plane polariscope by Jones calculus, isoclinics & isochromatics, Fringe order determination, determination of fractional fringe order, photo-elastic model materials and Applications.	
UNIT-2	**TWO DIMENSIONAL PHOTOELASTICITY**	**06**
	Separation methods: Shear difference method, Analytical separation methods, Model to prototype scaling, Properties of 2D photo-elastic model materials, materials for 2D photo-elasticity.	
UNIT-3	**BRITTLE COATINGS**	**06**
	Coatings stresses, crack patterns, refrigeration techniques, load relaxation techniques, crack detection methods, types of brittle coatings, resin and ceramic based brittle coatings, calibration of coating, advantages and brittle coating applications.	
UNIT-4	**PHOTOELASTIC(BIREFRINGENT) COATINGS**	**10**
	Theory of birefringence coating stresses, sources of error, effects of coating thickness: reinforcing effects, poission's, stress separation techniques: oblique incidence, strip coatings. Stress freezing technique, birefringent coating materials. **MOIRE METHODS:** Moiré fringes produced by mechanical interference. Geometrical approach, out of plane displacement measurements, applications and advantages.	
UNIT-5	**ELECTRICAL RESISTANCE STRAIN GAUGES**	**10**
	Gauged factors & strain sensitivity in metallic alloys, gauge construction, characteristics of strain gauges, adhesives and mounting techniques, gauge sensitivity and gauge factor, performance characteristics, environmental effects,	

	strain gauge circuits. Wheatstone's potentiometer bridges, constant current strain gauge circuits. **STRAIN ANALYSIS METHODS:** Two element, three element rectangular and delta rosettes, stress-strain relations, correction for transverse strain effects. **FORCE, TORQUE AND STRAIN MEASUREMENTS:** Mass balance measurement, Elastic element for force measurements, torque measurement.	

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

COURSE OUTCOMES: On completion of the course, students will be able to

CO1: Analyze stresses within the elastic range of materials.

CO2: Compile strains and displacements.

CO3: Evaluate stress and strain relations for linear elastic materials.

CO4: Describe the importance of experimental methods in analyzing stress and strain.

CO5: Describe photo elastic, Moiré technique, force, torque and strain measurements of experimental stress analysis Validate results with experiments.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	2	1	1	1	1	2	1	1
CO2	3	3	2	3	1	1	1	2	1	1	1	2
CO3	3	3	3	2	2	1	1	1	2	1	1	1
CO4	3	3	3	1	2	1	1	1	1	2	1	2
CO5	3	3	2	2	1	1	1	1	2	1	1	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2019-20 ACADEMIC YEAR: 2021-22
SEMESTER : FIFTH

COURSE TITLE : COMPUTER AIDED MANUFACTURING LABORATORY		
Sub Code: 18MEL57	**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**	**SEE Marks : 50**
Pre-requisites	**CADM**	

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 : 2019-20 ACADEMIC YEAR: 2021-22
SEMESTER : FIFTH

COURSE TITLE : FUEL TESTING AND INTERNAL COMBUSTION ENGINES LABORATORY		
Sub Code: 18MEL58	**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 : 2019-20 ACADEMIC YEAR: 2021-22
SEMESTER : SIXTH

COURSE TITLE : DESIGN OF MACHINE ELEMENTS – II		
Sub Code: 18ME61	**No of Credits =04** **L-T-P-SS:: 3:2:0:0**	**No. of lecture hours/week: 04** **Total Number of Lecture hours : 65**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**
Pre-requisites	**MOM, KOM, Design of Machine Elements-I**	

COURSE OBJECTIVES:

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

UNIT	**CONTENTS**	**Hrs**
UNIT-1	**CURVED BEAMS & DESIGN OF IC ENGINE COMPONENTS**	**9L+4T**
	Curved Beams: Assumptions made in the analysis of curved beams, stress equation, difference between straight and curved beam, Design of curved beams: Bending stresses and resultant normal stress in curved beams of standard cross sections used in crane hook, punching presses & clamps, closed rings and links. Numericals **Design of IC engine components**: Piston, Connecting rod.	
UNIT-2	**SPRINGS**	**9L+4T**
	SPRINGS: Introduction, classification of springs, stresses in helical coil springs of circular sections, deflection equation, energy stored in springs and problems on helical coil springs, buffer springs, concentric springs- advantages, applications and design of concentric springs, springs under fluctuating loads. Leaf Springs, advantages and applications, nipping, stresses in leaf springs, semi elliptical leaf spring. Numericals	
UNIT-3	**POWER TRANSMISSION**	**9L+4T**

	SPUR GEAR DRIVES: Introduction, classification, advantage, dis-advantages and applications, terminology of spur gears, material selection for spur gear design, stresses in gear tooth, Lewis equation and form factor, calculation of centre distance, module and face width, Check for dynamic and wear load considerations and numerical problems on spur gear. Introduction to Gear Box. **HELICAL GEARS:** Introduction, classification, advantage, dis-advantages and applications, terminology of helical gears, formative number of teeth, material selection for helical gear design, stresses in gear tooth, Lewis equation and form factor, Estimation of centre distance, module and face width, Check for dynamic and wear load considerations and numerical problems on spur gear.	
UNIT-4	**BEVEL GEARS and WORM GEARS**	**9L+4T**
	BEVEL GEARS: Introduction, classification, advantage, applications, terminology of bevel gears, formative number of teeth, material selection for bevel gear design, stresses in gear tooth: Lewis equation and form factor, design for strength, dynamic load and wear load, problems on bevel gear. **WORM GEARS**: Introduction, classification, advantage, applications, terminology of worm gears, material selection for worm gear design, stresses in gear tooth: Lewis equation, Design for strength, Dynamic load and wear loads and efficiency of worm gear drives and Numerical problems on worm gears.	
UNIT-5	**LUBRICATION and BEARINGS**	**9L+4T**
	LUBRICATION: Introduction to Lubrication and their properties, types of lubrication, Mechanisms of Lubrication, bearing modulus, coefficient of friction, minimum oil film thickness, Heat generated, Heat dissipated. Types and selection of Mechanical Seals. **BEARINGS:** Classification, Bearing Materials, types of bearing and designation, Selection of rolling contact bearings based on constant / variable load & speed conditions (includes deep groove ball bearing, cylindrical roller, spherical roller, taper roller, self-aligning bearing and thrust bearing). Design of ball bearing and journal bearing. Thrust bearings. Numerical problems**.**	

TEXT BOOKS

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

REFERENCE BOOKS

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

DESIGN DATA HANDBOOK

1. **Design Data Hand Book**, K. Lingaiah, McGraw Hill, 2nd Edition.

2. **Data Hand Book,** K. Mahadevan and Balaveera Reddy, CBS Publication
3. **Design Data Hand Book,** H.G. Patil, ShriShashi Prakashan, Belgaum.

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

CO1: Design and evaluate a mechanical system (straight and curved beams with symmetric and non-symmetric sections for various engineering applications)/process which is environment friendly with appropriate consideration for public health and safety. Understanding basic design of piston and connecting rod.

CO2: Analyze & design helical compression & tension springs with respect to static & dynamic axial loads

CO3: Design gears based on the given conditions and select appropriate gears for power transmission on the basis of given load and speed experienced to design spur and helical gears with respect to tooth bending strength. Implementation of different gears in gear box.

CO4: Design gears based on the given conditions and select appropriate gears for power transmission on the basis of given load and speed experienced to design bevel, & worm gears with respect to tooth bending strength

CO5: Compute equivalent radial loads for rolling contact bearing & select appropriate bearing for industrial applications using manufacturer's catalogue data.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	2	2	3	2	3	1	3	3
CO2	2	3	3	2	3	3	3	1	2	3	3	2
CO3	3	3	2	3	3	3	3	1	3	2	3	2
CO4	3	3	2	3	3	2	3	2	1	2	3	3
CO5	3	3	3	3	2	2	3	2	3	1	3	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										
3.Design Data Hand Book is permitted										

ADMISSION YEAR : 2019-20 ACADEMIC YEAR: 2021-22
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**	**SEE Marks : 50**
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**	**9L+4T**
	Introduction - Modes of heat transfer, Basic laws, Combined heat transfer mechanism, Resistance concept, Boundary conditions of 1^{st}, 2^{nd} and 3^{rd} 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; Related numerical problems	
UNIT-2	**EXTENDED SURFACES AND UNSTEADY STATE HEAT CONDUCTION TRANSFER**	**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**	**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 Related numerical problems	
UNIT-4	**HEAT EXCHANGERS**	**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**	**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 separated 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; 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												

SEMESTER : SIXTH

COURSE TITLE : MECHANICAL VIBRATIONS		
Sub Code: 18ME63	**No of Credits =03** **L-T-P-SS::2:2:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 52**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**
Pre-requisites	**Engineering Physics, DOM**	

COURSE OBJECTIVES:

1.To study basic concepts of vibration analysis and observe, analyze, understand the concept of vibrations in mechanical systems , various technique to solve single degree freedom and single DOF without damping with damping, 2-degree, forced vibration and, Estimate natural frequency of mechanical system multi degree freedom system using various numerical techniques.

2. To acquaint with the principles of vibration measuring instruments

3. To recognize how to apply theory of vibration to engineering problems.

4. To study balancing of mechanical systems, and able to mathematically formulate real-world vibration problems in engineering.

#	CONTENTS	Hrs
UNIT-1	**BASIC CONCEPTS OF VIBRATION:** Vibration and oscillation, causes and effects of vibrations, Vibration parameters – spring, mass, damper, Damper models, Motion – periodic, non-periodic, harmonic, non- harmonic, Degree of freedom, static equilibrium position, Vibration classification, Steps involved in vibration analysis. Definitions, Simple Harmonic Motion (S.H.M.), Work done by harmonic force, Beats and Numerical. **FREE UNDAMPED SINGLE DEGREE OF FREEDOM VIBRATION SYSTEMS:** 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.	**8L+3T**
UNIT-2	**FREE DAMPED SINGLE DEGREE OF FREEDOM VIBRATION SYSTEMS:** Types of damping**,** Analysis with viscous damping - Derivations for over damped, critically damped and under damped systems, Logarithmic decrement and numerical.	**7L+3T**
UNIT-3	**FORCED VIBRATIONS:** Introduction**,** Analysis of forced vibration with constant harmonic excitation - magnification factor, rotating and reciprocating unbalances, support excitation for relative and absolute amplitudes, force and motion transmissibility and numerical. **Rotor Dynamics:** Critical speed of single rotor, undamped and damped vibrations and numerical. **Vibration Measurement**: Principle of seismic instruments, vibrometer, and accelerometer - undamped, damped, Frequency measuring instruments.	**8L+3T**
UNIT-4	**SYSTEMS WITH TWO DEGREES OF FREEDOM:** Principle modes and normal modes of vibrations, natural frequencies of systems (without damping) – Simple spring mass systems, torsional systems, combined rectilinear and angular systems, geared semi-defined systems, semi-definite systems, Dynamic vibration absorber and numerical.	**8L+2T**

UNIT-5	**NUMERICAL METHODS FOR MULTI DEGREE FREEDOM OF SYSTEMS**: **(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 Numerical	**8L+2T**

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, Dhanpat Rai& 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 : 2019-20 **ACADEMIC YEAR: 2021-22**
SEMESTER : SIXTH

COURSE TITLE : INSPECTION AND QUALITY CONTROL (PROFESSIONAL ELECTIVE – 2)		
Sub Code: 18ME641	**No of Credits =03** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**Exam Marks : 50**
Pre-requisites	**Engineering Mathematics**	

COURSE OBJECTIVES:

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

#	CONTENTS	Hrs.
UNIT-1	**INDUSTRIAL INSPECTION and CONCEPT OF QUALITY IN ENGINEERING**	**08**
	Industrial inspection: Objectives and functions of inspection in industry, types of inspection, production / inspection interaction, organization for industrial inspection, inspection procedures, economic aspect of inspection. **Concept of Quality in Engineering:** Meaning and significance of quality; essential components of quality; phases or elements for building quality; evolution of the concepts of quality; spiral of progress of quality; quality cost, hidden quality costs; economic models of quality costs, changing scope of quality activities.	
UNIT-2	**QUALITY MANAGEMENT SYSTEMS , QUALITY CONTROL FUNCTION and ASPECTS OF SPECIFICATION AND TOLERANCES**	**08**
	Quality Control Function: Inspection versus quality control techniques, quality planning activities, organization for quality control. Fundamentals of statistical quality control, Juran's quality trilogy. **Aspects Of Specification And Tolerances:** Aspects of Specification and Tolerances: purpose of specification and tolerances, effect of careless setting of specification limits, setting realistic tolerances, statistical tolerancing, statistical theorem, Precision. Reproducibility and Accuracy, Simple numerical problems.	
UNIT-3	**CONTROL CHARTS**	**07**
	Control Charts: Basics of Control Chart: Variability, Kinds of variations, Types of errors, Control limits specification limits and Natural Tolerance limits, Charts for variables and attributes, application of control charts for averages, range, standard deviation, Interpretation of X-bar and R Charts- cyclic patterns, mixture, shift, trend and stratification, fraction defectives (p Chart) and number of non-conformities per unit (c Chart), process capability analysis and simple numerical problems.	
UNIT-4	**ACCEPTANCE SAMPLING & RELIABILITY**	**08**
	Acceptance Sampling: Elementary concepts, sampling by attributes, single, double and multiple sampling plans, construction and use of operating characteristic curves and simple problems.	

	Reliability: Reliability engineering, rectification processes in industries, practical activity – quality report building, reliability function, failure rate, mean time between failures (MTBF), mean time to failure (MTTF), mortality curve, useful life availability, maintainability, system effectiveness and simple numerical problems on reliability, MTBF and MTTF.	
UNIT-5	**QUALITY TOOLS AND SYSTEMS & TOTAL QUALITY MANAGEMENT**	**08**
	Quality Management Systems: Introduction to various quality standards - ISO 9000, BIS. **Quality Tools:** Ishikawa's seven quality tools; Quality Circles; Quality system economics. **Total Quality Management (TQM)** – definition, objectives, philosophy, and total productive maintenance (TPM) – definition, objectives, principles, implementation of TPM. Difference between TQM and TPM.	

TEXT BOOKS

1. Juran, J. M. and Gryna, F. M., Quality Planning & Analysis, Tata McGraw Hill, New Delhi (1995).
2. Grant, E. L., Statistical Quality Control, McGraw Hill International, New York (2005).
3. Charles E Ebling, An introduction to reliability and maintainability engineering, Tata McGraw-Hill Education, 2004 – Maintainability (Engineering).

REFERENCE BOOKS

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

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

CO1: Gain a knowledge on industrial inspection activity and concept of quality in engineering.

CO2: Understand various quality systems, quality control function, specification and tolerances prevalent in industry.

CO3: Construct various control charts based on data available in an industrial production, can also dwell upon the status of a process whether in control or out of control and find number of defectives.

CO4: Carry out sampling, reliability techniques with an industrial application.

CO5: Learn about applying different quality tools and total quality management.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	3	1	0	0	2	1	2	2
CO2	3	3	2	1	3	1	0	0	1	1	2	1
CO3	3	3	2	1	3	1	0	0	2	1	2	2
CO4	3	2	3	1	3	1	0	0	2	1	2	2
CO5	3	3	2	1	3	1	0	0	2	1	2	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2019-20 **ACADEMIC YEAR: 2021-22**
SEMESTER : SIXTH

COURSE TITLE : ADVANCED WELDING TECHNOLOGY (PROFESSIONAL ELECTIVE – 2)		
Sub Code: 18ME642	**No of Credits =03** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**
Pre-requisites	**Manufacturing Processes**	

COURSE OBJECTIVES

1. To understand the working principle, advantages, disadvantages of arc, gas and thermit welding.
2. The student gains information on different solid-state welding processes.
3. To understand the working principle, weld characteristics and process parameters of power beam welding and weld joint preparation and temperature control.
4. To understand the process of thermal cutting of materials, brazing and soldering.
5. To understand the concept about underwater welding, welding in space and welding metallurgy.

#	CONTENTS	Hrs.
UNIT 1	**INTRODUCTION TO WELDING PROCESSES**	**08**
	Classification of welding processes, energy sources used in welding, working principle, process variables, advantages, limitations and applications of electro slag and electro gas welding, resistance spot welding, gas welding, plasma arc welding and thermit welding.	
UNIT 2	**SOLID STATE WELDING PROCESSES**	**08**
	Working principle, process variables, advantages, limitations and applications of Forge welding, Forge-seam welding, cold welding, roll welding, friction welding and Inertia welding, friction stir welding, ultrasonic welding, diffusion welding and explosion welding.	
UNIT 3	**POWER BEAM WELDING PROCESSES WELD JOINT PREPARATION AND TEMPERATURE CONTROL**	**07**
	Working principle, process variables, advantages, limitations and applications of Electron beam and Laser beam welding Weld joint preparation and temperature control: Checks prior to weld joint preparation, joint preparation checks, preheating and interpass heating, post weld heating, heating processes, post heat treatments, insulation of heated joints.	
UNIT 4	**BRAZING, SOLDERING AND THERMAL CUTTING**	**08**
	Introduction, brazing, soldering, various techniques, their advantages, limitations and applications; brazing & soldering consumables. Oxy- Acetylene cutting-working principle, metal powder cutting, introduction to oxygen/air / plasma / metal arc cutting arc cutting and gouging; advantages, limitations and applications of various techniques	
UNIT 5	**UNDERWATER WELDING, WELDING IN SPACE AND WELDING METALLURGY**	**08**
	Introduction to wet and dry under water welding & cutting Introduction, welding techniques, difficulties and advantages of welding in space. Welding metallurgy: Introduction, thermal cycles, prediction of peak temperature, pre heat and cooling rate, Heat affected zone and weld metal: Transformations in HAZ of steel, factors affecting changes in microstructure and mechanical properties of HAZ, reactions in weld pool- gas metal reaction, slag metal reaction. Weldability of carbon steel,	

	stainless steel & aluminum. Hot & cold cracking phenomenon, weld defects, causes and their remedies. Welding of Cu, Al, Ti and Ni alloys – processes, difficulties, microstructures, defects and remedial measures.	

TEXT BOOKS:

1. S.V.Nadkarni, "Modern Arc Welding Technology", Oxford & IBH.
2. R.Little, "Welding Technology, TMH. WELDING CODES AND STANDARDS ME-9111 L T P.
3. Welding metallurgy by Sindo Kou, Welding metallurgy, 2nd Edition Nov. 2002, Wiley

REFERENCE BOOKS:

1. H.B.Cary, "Modern Arc Welding Technology", Englewood Cliffs, Prentice Hall.
2. Leonard P Connor, Welding Hand book, Volume I-III, AWS.
3. Metals Hand book, Volume 6, American Society of Metals.
4. Dave Smith, "Welding skills and technology", McGraw Hill.
5. Parmer R. S., 'Welding processes and Technology", Khanna Publishers, 1997
6. Robert W Messler, Jr. " Principles of welding, Processes, physics, chemistry and metallurgy", Wiley,2004.
7. Larry Jeffus, " Welding Principles and Applications" Fifth edition, Thomson,2002
8. Christopher Davis, 'Laser Welding - A Practical Guide', Jaico Publishing House, 1994.
9. Mishra. R.S and Mahoney. M.W, Friction Stir Welding and Processing, ASM,2007
10. Lancaster J F, "Metallurgy of welding", Allen and Unwin Co
11. Larry J and Jeffus L, "Welding Principles and Applications", 5th edition, Delmer Publications.

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

CO1: Understand the mechanism, working principle and process characteristics of different arc, gas and thermit welding processes.

CO2: Have in depth knowledge on working principle, process characteristics of friction, friction stir, ultrasonic, explosion welding and diffusion bonding.

CO3: Describe the mechanism, working principle and process characteristics of high energy beam welding.

CO4: Differentiate between **s**oldering and brazing, their techniques, advantages and limitations, applications and also decide on best cutting techniques for a specific application and their limitations.

CO5: Describe working principle and process characteristics of underwater welding processes, welding in space. And also Welding and weldability of different metals, hot& cold cracking phenomenon, weld defects and their causes and remedies.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	3	1	2	0	1	1	1	1	1	0
CO2	2	3	2	1	2	0	0	1	1	2	1	1
CO3	3	3	2	1	2	0	1	1	1	2	1	1
CO4	2	3	3	1	2	0	0	1	1	2	0	1
CO5	3	2	3	1	2	0	1	1	0	1	1	0
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2019-20 ACADEMIC YEAR: 2021-22
SEMESTER : SIXTH

COURSE TITLE: INTERNAL COMBUSTION ENGINES (PROFESSIONAL ELECTIVE - 2)		
Sub Code: 18ME643	**No of Credits: L-T-P-SS 03:00:00:00 =03**	**No. of lecture hours/week: 03 Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**
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.

UNITS	CONTENTS	Hrs.
UNIT 1	**REVIEW OF I.C. ENGINE CYCLES AND CARBURETION**	**07**
	Review of thermodynamics cycles used in IC engines; Introduction to carburetion, air-fuel mixture requirement at different loads and speeds, Automotive air-fuel mixture requirement, principle of carburetion, simple carburettor, calculation of air-fuel ratio, essential parts of a carburettor, compensating devices, additional systems in modern carburettors, types of carburettors, automobile carburettors, altitude compensation, Numerical problems on air-fuel mixture and carburetion.	
UNIT 2	**MECHANICAL AND ELECTRONIC INJECTION SYSTEMS**	**09**
	Introduction to mechanical injection system; Functional Requirements of an Injection System; Classification of Injection Systems; Fuel Feed Pump, Injection Pump - Jerk Type Pump, Distributor Type Pump; Injection Pump Governor, Mechanical Governor; Pneumatic Governor; Fuel Injector; Nozzle - Types of Nozzle; Spray Formation, Quantity of Fuel and the Size of Nozzle Orifice; Injection in SI Engine; Introduction to electronic injection system; Gasoline injection - Types of Injection Systems, Components of Injection System; Electronic Fuel Injection System - Merits and Demerits of EFI System; Multi-Point Fuel Injection (MPFI) System; Functional Divisions of MPFI System; Injection Timing; Group Gasoline Injection System; Electronic Diesel Injection System; Electronic Diesel Injection Control; Numerical problems on mechanical injection system.	
UNIT 3	**COMBUSTION IN SPARK IGNITION AND COMPRESSION IGNITIION ENGINES**	**09**
	Introduction; Homogeneous Mixture; Heterogeneous Mixture; Combustion in Spark–Ignition Engines; Stages of Combustion in SI Engines; Flame Front Propagation; Factors Influencing the Flame Speed; Rate of Pressure Rise; Abnormal Combustion; The Phenomenon of Knock in SI Engines, Effect of Engine Variables on Knock; Combustion Chambers for SI Engines; Combustion in Compression-Ignition Engines; Stages of Combustion in CI Engines; Factors Affecting the Delay Period; The Phenomenon of Knock in CI Engines; Comparison of Knock in SI and CI Engines; Combustion Chambers for CI Engines.	
UNIT 4	**ENGINE ELECTRONICS AND SUPERCHARGING**	**07**
	Introduction; Typical Engine Management Systems; Different types of Position Displacement and Speed, Pressure, Temperature, Intake air flow and Exhaust oxygen	

	measurement sensors and transducers; Supercharging – Introduction; Types Of Superchargers – Centrifugal, Root's and Vane Type; Methods of Supercharging - Electric Motor Driven, Ram Effect, Under Piston, and Kadenacy System of Supercharging; Effects of Supercharging; Limitations to Supercharging; Thermodynamic Analysis of Supercharged Engine Cycle; Power Input for Mechanical Driven Supercharger; Gear Driven and Exhaust Driven Supercharging Arrangements; Turbocharging - Charge Cooling; Numerical problems on supercharged engines.	
UNIT 5	**NON CONVENTIONAL ENGINES**	**07**
	Introduction; Comprehensive study on working principle, thermodynamic analysis, design, types, advantages and disadvantages of the following types of engines - Common Rail Direct Injection Engine; Dual Fuel and Multi-Fuel Engines; Multi-fuel Engines; Gasoline Direct Injection Engine; Homogeneous Charge Compression Ignition (HCCI) Engine; Lean Burn Engine; Stirling Engine; Stratified Charge Engine; Variable Compression Ratio Engine; Wankel Engine; Hybrid electric vehicle (HEV), Introduction to Electric Vehicle Propulsion Systems, Motors and Controls for Electric Vehicles Applications, Storage technologies for EV, Battery pack and battery management system, Solar powered EVs.	

TEXT BOOKS

1. **Internal Combustion Engines**, V. Ganesan, Tata Mc-Graw Hill Publications,4th Edition, 2012.
2. **A Text Book of Internal Combustion Engines**, R.K. Rajput, Laxmi Publishers, 2007.
3. **Internal Combustion Engines**, M. L. Mathur and R. P. Sharma, Dhanpat Rai Publications, 2014.

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REFERENCE BOOKS

1. **Internal Combustion Engine Fundamentals**, John B. Heywood, Mc-Graw Hill Education India Limited, 2011.
2. **Engineering Fundamentals of the Internal Combustion Engines,** WillardW Pulkrabek. Pearson Education, 2nd Edition, 2015.

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

CO1: Describe the carburetion and working principle of different type of carburettor. (RBTL: 1, 2, 3)

CO2: Explain the fuel injection systems in IC engines. (RBTL: 1, 2, 3)

CO3: Describe the combustion process and select suitable combustion chambers for IC engines. (RBTL: 1, 2, 3)

CO4: Understand the engine electronics and supercharging and solve problems on supercharged engines. (RBTL: 1, 2, 3)

CO5: Differentiate and select non-conventional engines in the context of modern developments. (RBTL: 1, 2, 3)

(RBTL: Revised Bloom's Taxonomy Levels; 1 – Remembering, 2 – Understanding, 3 – Applying, 4 - Analyzing, 5 - Evaluating, 6 - Creating)

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	0	2	0	0	0	0	0	0	2
CO2	3	3	2	0	2	0	2	0	0	0	0	2
CO3	3	3	2	0	2	0	0	0	0	0	0	2
CO4	3	3	3	3	3	0	0	0	0	2	0	2
CO5	3	3	2	1	3	3	3	0	0	2	0	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2019-20 ACADEMIC YEAR: 2021-22
SEMESTER : SIXTH

COURSE TITLE : PRODUCTION AND OPERATIONS MANAGEMENT (PROFESSIONAL ELECTIVE - 2)		
Sub Code: 18ME644	**No of Credits =03** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**
Pre-requisites	**Knowledge of Calculus and Probability**	

Course Objective:

1. Develop an understanding of and an appreciation for the production and operations management function in any organization.
2. To understand the importance of productivity and competitiveness to both organizations and nations.
3. To understand the importance of an effective production and operations strategy to an organization.
4. To understand the various production and operations design decisions and how they relate to the overall strategies of organizations.
5. To understand the relationship of the various planning practices of capacity planning, aggregate planning, project planning and supply management.

UNITS	CONTENTS	Hrs.
UNIT- 1	**PRODUCTION & OPERATIONS MANAGEMENT CONCEPTS**	**08**
	Introduction, Historical Development, Operations Management Definition, Production and Manufacturing Systems, Products v/s Services, Productivity, Factors affecting Productivity, International Dimensions of Productivity, The environment of operations, Operational excellence and world class manufacturing practices. **Operations Decision Making**: Introduction, Characteristics of decisions, framework for Decision Making, Decision methodology, Decision supports systems, Economic models, Statistical models. (Simple numericals)	
UNIT- 2	**SYSTEM DESIGN & CAPACITY PLANNING**	**08**
	Design capacity, System capacity, and Determination of Equipment requirement. Facility Location and Facility Layout, Location Planning for Goods and Services, Foreign locations and facility layout. (Simple numericals)	
UNIT- 3	**FORECASTING, AGGREGATE PLANNING AND MASTER**	**08**
	Forecasting: Forecasting Objectives and Uses, Forecasting Variables, Opinion and Judgmental methods, Time Series methods, Exponential smoothing, Regression and Correlation methods, Application and Control of Forecasts. (Simple numericals) **Aggregate Planning and Master Scheduling:** Introduction, Planning and Scheduling, Objectives of Aggregate Planning, Aggregate Planning Methods, Master Scheduling Objectives, Master Scheduling Methods. (Simple numericals)	

UNIT- 4	**INVENTORY CONTROL AND MATERIALS MANAGEMENT**	**08**
	Definition and Need, Components Inventory, inventory control. Scope of Materials Management, Material handling, storage and retrieval, purpose of inventories, Dependent and Independent demand, Inventory cost and Order quantities, Inventory classification and counting (Simple numericals)	
UNIT- 5	**MATERIAL, CAPACITY REQUIREMENTS PLANNING AND PURCHASING & SUPPLY MANAGEMENT**	**07**
	Material and Capacity Requirements Planning: Overview: MRP and CRP, MRP: Underlying Concepts, System Parameters, MRP Logic, System refinements, Capacity Management, CRP activities. Concept of continuous improvement of process. (Simple numericals) **Purchasing & Supply chain Management**: Purchase and supply chain management. Approaches to purchase and supply chain management, make or buy decision, eProcurement, Vender development, rating, and certification.	

TEXT BOOKS:

1. Operations Management, I. B. Mahadevan. Theory and practice, Pearson, 2007.
2. Operations Management, Monks, J.G., McGraw-Hili International Editions, 1987.

REFERENCE BOOKS:

1. Modern Production/Operations Management, Buffa, Wiley Eastern Ltd.2001
2. Production and Operations Management, Pannerselvam. R., PHI. 2002
3. Productions & Operations Management, Adam & Ebert. 2002
4. Production and Operations Management, Chary, S. N., Tata-McGraw Hill. 2002

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

CO1: Appreciate the production and operations management function in any organization.

CO2: Explain importance of productivity and competitiveness to both organizations and nations.

CO3: Explain importance of an effective production and operations strategy to an organization.

CO4: Explain various production and operations design decisions and how they relate to the overall strategies of organizations.

CO5: Explain relationship of the various planning practices of capacity planning, aggregate planning, project planning and supply management.

MAPPING OF COs WITH POs												
COs/POs	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	0	2	0	0	0	0	0	0	2
CO2	3	3	2	1	2	0	2	0	0	0	0	2
CO3	3	3	2	1	2	0	0	0	0	0	0	2
CO4	3	3	3	3	2	2	0	0	0	2	0	2
CO5	3	3	2	1	3	3	3	0	0	2	0	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2019-20 ACADEMIC YEAR: 2021-22
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**	**SEE Marks : 50**
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**	**10**
	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, Node numbering, Half band width, Definitions of FEA and FDM. **BASIC PROCEDURE**: Euler - Langrange equation for bar, beam (cantilever / simply supported fixed), principle of minimum potential energy, Raleigh's Ritz method. Direct approach for stiffness matrix formulation of bar element. Galerkin's method boundary conditions and general comments.	
UNIT-2	**INTERPOLATION MODELS**	**08**
	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. **SOLUTION OF 1-DIMENSIONAL BARS:** Solutions of bars and stepped bars for displacements, reactions and stresses by using penalty approach and elimination approach. Guass-elimination technique. Applications.	
UNIT-3	**HIGHER ORDER ELEMENTS**	**05**
	Lagrange's interpolation, Higher order one dimensional elements-Quadratic and cubic element and their shape functions. Shape function of 2-D quadrilateral element-linear, quadric element iso-parametric, Sub parametric and Super parametric elements.	
UNIT-4	**TRUSSES & BEAMS**	**10**
	2D truss Elements Stiffness matrix of Truss element. Examples illustrating how to obtain various internal force diagrams for different types of structural member like trusses Numerical problems. 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**	**06**
	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.

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 interpolation function and analysis of Bar elements.
CO3: To imbibe the concept of shape shape functions of higher order elements.
CO4: Gain the knowledge and able to analyze the structural applications of trusses and beams 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 : 2019-20 ACADEMIC YEAR: 2021-22
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**	**SEE Marks : 50**
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**	**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**	**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**	**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**	**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**	**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 dependent 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 : 2019-20 **ACADEMIC YEAR: 2021-22**
SEMESTER : SIXTH

COURSE TITLE : FLUID MECHANICS AND MACHINES 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**	**SEE 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 : 2019-20 ACADEMIC YEAR: 2021-22
SEMESTER : SIXTH

COURSE TITLE : HEAT TRANSFER LABORATORY		
Sub Code: 18MEL67	**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**	**SEE 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 : 2019-20 **ACADEMIC YEAR: 2021-22**
SEMESTER : SIXTH

COURSE TITLE : MINI - PROJECT WORK		
Sub Code: 18MEMP68	**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**	**SEE 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 EXAMINATION (CIE)

1. Departments shall constitute a Departmental Project Review Committee (internal guide + faculty) to review the project at the middle of the semester.
2. Internal guide alone shall evaluate the project at the end of the semester for a maximum of 35 marks.
3. Project Review Committee shall evaluate the project at the end of the semester for a maximum of 15 marks.

SCHEME OF EVALUATION (CIE)			
Guide (MAX MARKS)	**PROJECT REVIEW COMMITTEE**		
	PARTICULARS	**(MAX MARKS)**	**TOTAL MARKS**
35	Relevance of topic	**05**	**50**
	Oral presentation	**05**	
	Viva Voce	**05**	
	TOTAL	**15**	

SCHEME OF VALUATION FOR SEE: Evaluation of the project by both internal and external examiners for a maximum of 50 marks by conducting project viva-voce.

SCHEME OF EVALUATION (SEE)		
Sl. No.	**Particulars**	**Max. Marks**
1	Relevance of the subject in the present context	**05**
2	Literature Survey	**05**
3	Problem formulation	**05**
4	Experimental observation / theoretical modelling	**05**
5	Results – Presentation & Discussion	**05**
6	Conclusions and scope for future work	**05**
7	Overall presentation of the Thesis/Oral presentation	**20**
	Total Marks	**50**

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.

COLOUR OF THE OUTER COVER/FRONT PAGE OF UG DISSERTATION / PROJECT REPORT - SKY BLUE

Dr. AMBEDKAR INSTITUTE OF TECHNOLOGY

(An autonomous institution, Aided by Govt. of Karnataka, Affiliated to VTU)
BDA Outer Ring Road, Near Jnana Bharathi Campus, Bengaluru - 560056

Department of Mechanical Engineering

CERTIFICATE

Certified that the Mini project work (Sixth Semester) entitled…… is carried out by the following bonafide students of Mechanical Engineering in partial fulfillment for the award of Bachelor of Engineering, B. E (Mechanical) at **Dr. Ambedkar Institute of Technology, Bangalore,** during the academic year ..... .

Sl. No	U S N (ascending order)	Name of Student

It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the project report.

The project report has been approved satisfying the academic requirements prescribed for the said Degree.

Guide	**HOD**	**Principal**

External Viva:

Sl. No	Name of the examiner	Signature with date
1		
2		

ADMISSION YEAR : 2019-20 ACADEMIC YEAR: 2021-22
SEMESTER : SIXTH

COURSE TITLE : INDUSTRY INTERNSHIP		
Sub Code: 18MEI69	**No of Credits =00** **L-T-P-SS::0:0:2:0**	

Internship: All the students admitted to III year of BE/B. Tech have to undergo mandatory internship of 4 weeks during the vacations of VI and VII semesters and /or VII and VIII semesters. A University examination will be conducted during VIII semester and prescribed credit are added to VIII semester. Internship is considered as a head of passing and is considered for the award of degree. Those, who do not take-up/complete the internship will be declared as failed and have to complete during subsequent University examination after satisfy the internship requirements.

OBJECTIVE:

1. To inculcate the working procedure in the students in the industry by incorporating their knowledge gained during engineering course.
2. Exposing the student community to the real working environment in the industry.

PROCEDURE FOR INTERNSHIP:

1. Students shall approach any one of small, medium or large scale industries of their choice and get permission for carryout internship for a minimum duration of four weeks.
2. Obtain a permission/recommendation letter from the college to the respective industry to permit him/her to carry out the internship.
3. After obtaining a permission from industry, fix the time period for internship (during their intervening vacations of VI and VII semester) after mutual discussion with the industry and the students. The same should be communicated to the department regarding the time period of internship.
4. Student should start and continue his/her internship with the assistance and guidance of the allotted authorised person to gain maximum knowledge of real time working in the industry.
5. Student should maintain a fact sheet of working (containing timings, machines, operations, softwares, programmes etc.) on day to day basis for his/her entire period of internship.
6. Obtain a signature in all the fact sheet from the authorised person under whom guidance he/she is working.
7. An internship certificate issued by that industry should be obtained and submitted to the department.
8. Immediately after completion of the internship he/she must prepare an internship report containing internship certificate and submit the report to the department for evaluation.

Dr. Ambedkar Institute of Technology, Bengaluru-560 056
SCHEME OF TEACHING AND EXAMINATION from Academic Year 2021-22
B.E MECHANICAL ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

VII SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical / Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	MC	18HS71	CMEP/OSHA	IM/CV	2	--	--	03	50	50	100	2
2	PC	18ME71	Control Engineering	ME	4	--	--	03	50	50	100	4
3	PC	18ME72	Operations Research	ME	4	--	--	03	50	50	100	4
4	PE	18ME73X	Professional Elective -3	ME	3	--	--	03	50	50	100	3
5	PE	18ME74X	Professional Elective -4	ME	3	--	--	03	50	50	100	3
6	OE	18XX75X	Open Elective - C		3	--	--	03	50	50	100	3
7	PC	18MEL76	Design Laboratory	ME	--	--	2	03	50	50	100	1
8	PC	18MEL77	Computer Aided Modelling and Analysis Laboratory	ME	--	--	2	03	50	50	100	1
9	Project	18MEP78	Project Work Phase - 1	ME	--	--	2	03	50	50	100	2

10	INT	18MEI79	Internship	(If not completed after VI semester examinations, it has to be carried out during the intervening vacations of VII and VIII semesters)				--	--	--	--	--
				TOTAL	**19**	**--**	**6**	**27**	**450**	**450**	**900**	**23**

Note: PC: Professional core, PE: Professional Elective, OE: Open Elective, INT: Internship, MC: Mandatory Course

Internship: All the students admitted to III year of BE/B.Tech have to undergo mandatory internship of 4 weeks during the vacations of VI and VII semesters and /or VII and VIII semesters. A University examination will be conducted during VIII semester and prescribed credit are added to VIII semester. Internship is considered as a head of passing and is considered for the award of degree. Those, who do not take-up/complete the internship will be declared as failed and have to complete during subsequent University examination after satisfy the internship requirements.

Course code	**Professional Electives - 3**	Open Elective - C
18ME731	Computer Integrated Manufacturing	Students can select any one of the open electives (Please refer to consolidated list of Dr AIT for open electives) offered by any Department. Selection of an open elective is not allowed provided, • The candidate has studied the same course during the previous semesters of the programme. • The syllabus content of open elective is similar to that of Departmental core courses or professional electives. • A similar course, under any category, is prescribed in the higher semesters of the programme. Registration to electives shall be documented under the guidance of Programme Coordinator / Mentor.
18ME732	Rapid Prototyping	
18ME733	Project Management	
18ME734	Solar Thermal Engineering	
18ME735	Mechanics Of Viscoelastic Materials	
Course code	**Professional Electives - 4**	
18ME741	Smart Materials	
18ME742	High Entropy Materials	
18ME743	Tribology and Bearing Design	
18ME744	Power Plant Engineering	
18ME745	Computational Fluid Dynamics	
	OPEN ELECTIVE – B	
18XX75X		

Dr. Ambedkar Institute of Technology, Bengaluru-560 056
SCHEME OF TEACHING AND EXAMINATION from Academic Year 2021-22
B.E MECHANICAL ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

VIII SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	MC	18HS81	CMEP/OSHA	IM/CV	4	--	--	03	50	50	100	2
2	Project	18MEP81	Project Work Phase - 2	ME	--	--	2	03	50	50	100	10
3	Seminar	18MES82	Technical Seminar		--	--	2	03	50	50	100	1
4	INT	18MEI83	Internship	(Completed during the intervening vacations of VI and VII semesters and /or VII and VIII semesters.)				03	50	50	100	2
				TOTAL	**04**	**--**	**04**	**12**	**200**	**200**	**400**	**15**

Note: PC: Professional Core, PE: Professional Elective, OE: Open Elective, INT: Internship, MC: Mandatory Course

Electives

Internship: Those, who have not pursued /completed the internship will be declared as failed and have to complete during subsequent SEE examination after they satisfy the internship requirements.

CMEP: Cost Management of Engineering Projects, OSHA: Occupational Safety and Health Administration

ADMISSION YEAR : 2018-19 **ACADEMIC YEAR: 2021-22**
SEMESTER : SEVENTH

COURSE TITLE : CONTROL ENGINEERING		
Sub Code: 18ME71	**No of Credits =04** **L-T-P-SS::4:0:0:0**	**No. of lecture hours/week : 04** **Total Number of Lecture hours : 52**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**
Pre-requisites	**Engineering Mathematics**	

COURSE OBJECTIVES:

1. Mathematical modeling of the mechanical systems using differential equations.
2. Deduction of Transfer functions using block Diagrams and signal flow graphs
3. Emphasize on transient characteristics and response of the systems and Routh-Hurwitz stability criteria
4. Analysis of frequency response characteristics of control systems.
5. Construction of root locus plots and to ascertain the stability of the control systems

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#	CONTENTS	Hrs
UNIT-1	**MECHANICAL CONTROL SYSTEMS**	**10**
	Introduction to the Concept of automatic controls, open loop and closed loop control systems, representation of feedback systems, requirements of an ideal control system. Temperature control, speed control and flight controls. Mathematical models**:** Transfer function models, models of mechanical systems (translational and rotational).	
UNIT-2	**BLOCK DIAGRAMS AND SIGNAL FLOW GRAPHS**	**08**
	Transfer Functions definition, blocks representation of systems, reduction of block diagrams, Mason's gain formula: signal flow graphs. Feed forward systems with examples, Positive Feedback systems.	
UNIT-3	**TRANSIENT AND STEADY STATE RESPONSE ANALYSIS**	**10**
	Introduction, first order and second order system response to step, ramp and impulse inputs, concepts of time constant and its importance in speed of response. System stability: Routh's-Hurwitz criterion; Types of controllers-proportional, integral proportional integral, proportional integral differential controllers. Compensation in control systems, lead-lag compensator.	
UNIT-4	**ROOT LOCUS PLOTS**	**12**
	Definition, general rules for constructing and analysis of closed loop and open loop systems using root locus plots. Effects of addition of poles and zeroes on stability of the systems. Introduction to MATLAB Programming for stability analysis of Root locus plots.	
UNIT-5	**FREQUENCY RESPONSE ANALYSIS**	**12**
	Asymptotic Approximations: Bode Magnitude and Phase angle plots. Stability, Gain Margin & Phase Margin via Bode plot. Polar plots, Nyquist stability criterion, Stability analysis, Relative stability concepts, Gain margin and phase margin. Introduction to MATLAB Programming for stability analysis of bode plots.	

TEXT BOOKS:

1. Modern Control Engineering, Ogata, 5th Edition , 2010, Prentice Hall of India, New Delhi.ISBN: 10: 0-13-615673-8, 13: 978-0-13-615673-4
2. Automatic Control Systems, Kuo, 3rd Edition, 2009, Prentice Hall of India, New Delhi, ISBN: 0-13-054973-8
3. Control Systems Engineering, 5th Edition, Norman S Nise, Wiley India - 2009

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.
4. Automatic Control Systems, B C Kuo, F Golnaraghi, John Wiley & Sons, 2003.
5. Control Engineering: MATLAB Exercises Authors: Keviczky, L., Bars, R., Hetthessy, J., Banyasz, C.

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

CO1: Describe fundamentals of control elements and mathematical modeling
CO2: To understand the block diagram and signal flow graphs.
CO3: Analyze steady state and transient response of first and second order systems.
CO4: Evaluate the system stability through Bode and Nyquist plots.
CO5: Construction and stability analysis using root locus plots.

MAPPING OF COs WITH POs												
COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	1	1	2	0	0	1	0	3
CO2	3	3	2	1	1	0	2	0	0	1	0	2
CO3	3	3	2	1	1	0	2	0	0	1	0	2
CO4	3	3	3	2	1	0	2	0	0	1	0	3
CO5	3	3	2	2	1	0	2	0	0	1	0	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2017-18 **ACADEMIC YEAR: 2020- 21**
SEMESTER : SEVENTH

COURSE TITLE : OPERATIONS RESEARCH (OPEN ELECTIVE –B)		
Sub Code: 18ME72	**No of Credits =4** **L-T-P-SS::4:0:0:0**	**No. of lecture hours/week : 04** **Total Number of Lecture hours : 52**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**
Pre-requisites	**Engineering Mathematics**	

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	Hrs
UNIT-1	**INTRODUCTION & SOLUTION OF LINEAR PROGRAMMING PROBLEMS**	**11**
	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. The simplex method-canonical and standard forms of an LP problem, slack, surplus and artificial variables (Numerical problems).	
UNIT-2	**TRANSPORTATION PROBLEM**	**10**
	Formulation of transportation problem, types, initial basic feasible solution using different methods, optimal solution by MODI method, degeneracy in transportation problems, application of transportation problem, maximization cases (online)	
UNIT-3	**ASSIGNMENT PROBLEM & SEQUENCING**	**10**
	Assignment Problem-formulation balanced and unbalanced types, application to maximization cases and travelling salesman problem (Numericals). Basic assumptions, sequencing using Johnson's algorithm, 'n' jobs 2 machines, 'n' jobs 3 machines, 'n' jobs 'm' machines without passing sequence, graphical solutions. **.:**	
UNIT-4	**PERT-CPM TECHNIQUES** (CLASSROOM TEACHING)	**11**
	Introduction, network construction - rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects.	
UNIT-5	**GAME THEORY & REPLACEMENT THEORY**	**10**
	Formulation of games, types, solution of games with saddle point, graphical method of solving mixed strategy games, dominance rule for solving mixed strategy games. Replacement items deteriorating with time, when money value remains same Replacement of items which fail suddenly; Individual replacement policy, Group	

	replacement policy.	

TEXT BOOKS:

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

REFERENCE BOOKS:

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

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

CO1: Define models for linear programming and convert the linear variable problems to a mathematical model and depict by graphical method.

CO2: Compute the minimum cost of transportation by NWCR, LCM and VAM method and then to find optimum solution by MODI method.

CO3: Find optimal assignment by Hungarian method.

CO4: Design a project network diagram and schedule the project activities and duration using PERT and CPM.

CO5: Illustrate the strategies of different players in a game and find the best strategy by graphical and dominance method.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	1	2	0	1	0	2	1	3	2	2
CO2	3	3	1	2	1	1	0	2	1	3	2	2
CO3	3	3	1	2	1	1	0	2	1	3	2	2
CO4	3	3	1	2	3	1	0	2	2	3	3	3
CO5	3	3	1	2	3	1	1	3	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.										

ADMISSION YEAR: 2018-19 **ACADEMIC YEAR: 2021-22**
SEMESTER : SEVENTH

COURSE TITLE : COMPUTER INTEGRATED MANUFACTURING (PROFESSIONAL ELECTIVE - 3)		
Sub Code: 18ME731	**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 : 50**
Pre-requisites	**Manufacturing Process I and II, CAD/CAM**	

Course Objectives:

1. To impart knowledge of CIM and Automation and different concepts of automation by developing mathematical models.
2. To expose students to automated flow lines, assembly lines, Line Balancing Techniques, and Flexible Manufacturing Systems.
3. To expose students to computer aided process planning, material requirement planning, capacity planning etc.
4. To introduce the students to concepts of Additive Manufacturing, Internet of Things, and Industry 4.0 leading to Smart Factory.

UNIT	CONTENT	Hrs.
UNIT 1	**Introduction to CIM and Automation:** Automation in Production Systems, automated manufacturing systems- types of automation, reasons for automating, Computer Integrated Manufacturing, computerized elements of a CIM system, CAD/CAM and CIM. Mathematical models and matrices: production rate, production capacity, utilization and availability, manufacturing lead time, work-in process, Numerical problems and automation strategies.	**08**
UNIT 2	**Automated Production Lines and Assembly Systems:** Fundamentals, system configurations, applications, automated flow lines, buffer storage, control of production line, analysis of transfer lines, analysis of flow lines without storage, partial automation, analysis of automated flow lines with Storage buffer, fundamentals of automated assembly systems, numerical problems.	**08**
UNIT 3	**Flexible Manufacturing Systems:** Fundamentals of Group Technology and Flexible Manufacturing Systems, types of FMS, FMS components, Material handling and storage system, applications, benefits, computer control systems, FMS planning and design issues, Automated Storage and Retrieval Systems, AS/RS and Automatic parts identification systems and data capture. **Line Balancing:** Line balancing algorithms, methods of line balancing, numerical problems on largest candidate rule, Kilbridge and Wester method, and Ranked Positional Weights method.	**08**
UNIT 4	**Computerized Manufacture Planning and Control System:** Computer Aided Process Planning, Retrieval and Generative Systems, benefits of CAPP, Production Planning and Control Systems, typical activities of PPC System, computer integrated production management system, Material Requirement Planning, inputs to MRP system, working of MRP, outputs and benefits, Capacity Planning, Computer Aided Quality Control, Shop floor control. **Automated Assembly Systems:** Design for automated assembly systems, types of automated assembly system, Parts feeding devices-elements of parts delivery system-hopper, part feeder, Selectors, feedback, escapement and placement. **Automated Guided Vehicle System**: Introduction, types, Vehicle guidance and	**08**

	routing, System management.	
UNIT 5	**Additive Manufacturing Systems:** Basic principles of additive manufacturing, slicing CAD models for AM, advantages and limitations of AM technologies, Additive manufacturing processes: Photo polymerization, material jetting, binder jetting, material extrusion, Powder bed sintering techniques, sheet lamination, direct energy deposition techniques, applications of AM. Recent trends in manufacturing, Hybrid manufacturing. **Future of Automated Factory:** Industry 4.0, functions, applications and benefits. Components of Industry 4.0, Internet of Things (IOT), IOT applications in manufacturing, Big-Data and Cloud Computing for IOT, IOT for smart manufacturing, influence of IOT on predictive maintenance, industrial automation, supply chain optimization, supply-chain & logistics, cyber-physical manufacturing systems.	**07**

TEXT BOOKS:

1. Automation, Production system & Computer Integrated manufacturing, M. P. Groover" 4th Edition, 2015, Pearson Learning.
2. Principles of Computer Integrated Manufacturing, S. Kant Vajpayee, Prentice Hall India.
3. CAD/CAM/CIM, Dr P Radhakrishnan, 3rd edition, New Age International Publishers, New Delhi.

REFERENCE BOOKS

1. "CAD/CAM" by Ibrahim Zeid, Tata McGraw Hill.
2. "Principles of Computer Integrated Manufacturing", S.Kant Vajpayee, 1999, Prentice Hall of India, New Delhi.
3. "Work Systems and the Methods, Measurement and Management of Work", Groover M. P, Pearson/Prentice Hall, Upper Saddle River, NJ, 2007.
4. "Computer Automation in Manufacturing", Boucher, T. O., Chapman & Hall, London, UK, 1996.
5. "Introduction to Robotics: Mechanics and Control", Craig, J. J., 2nd Ed., Addison-Wesley Publishing Company, Readong, MA, 1989.
6. Internet of Things (IoT): Digitize or Die: Transform your organization. Embrace the digital evolution. Rise above the competition, by Nicolas Windpassinger, Amazon.
7. "Internet of Things: A Hands-on Approach", by Arshdeep Bahga and Vijay Madisetti (Universities Press)
8. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 2nd Ed. (2015), Ian Gibson, David W. Rosen, Brent Stucker
9. "Understanding Additive Manufacturing", Andreas Gebhardt, Hanser Publishers, 2011
10. Industry 4.0: The Industrial Internet of Things, A press, 2017, by Alasdair Gilchrist.

COURSE OUTCOMES (COS): On completion of this course you should be able to:

CO1: Able to define Automation, CIM, CAD, CAM and explain the differences between these concepts.

CO2: Explain the basics of automated manufacturing industries through mathematical models and analyse different types of automated flow lines.

CO3: Analyse the FMS, GT, AS/RS and automated flow lines to reduce down time and enhance productivity.

CO4: Design and development of various types of Computerized Manufacture Planning and Control System, materials handling systems, CAPP, MRP, capacity planning, shop floor control and CAQC.

CO5: Visualize and appreciate the modern trends in Manufacturing like additive manufacturing, Industry 4.0 and applications of Internet of Things leading to Smart Manufacturing.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	2	1	1	1	1	2	1	1
CO2	3	3	2	3	1	1	1	2	1	3	1	2
CO3	3	3	3	2	2	1	1	1	2	3	1	1
CO4	3	3	3	1	2	1	1	1	1	2	1	2
CO5	3	3	3	1	2	1	1	1	1	2	1	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2018-19 **ACADEMIC YEAR: 2021-22**
SEMESTER : SEVENTH

COURSE TITLE : RAPID PROTOTYPING (PROFESSIONAL ELECTIVE - 3)		
Sub Code: 18ME732	**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 : 50**
Pre-requisites	**Manufacturing Processes**	

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	Hrs.
UNIT-1	**INTRODUCTION**	**07**
	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	**SELECTIVE LASER SINTERING (SLS) PROCESS**	**08**
	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**	**08**
	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**	**08**
	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 RAPID PROTOTYPING**	**08**
	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

REFERENCE BOOKS:

1. Rapid Prototyping, Terry Wohler's Report 2000" Wohler's Association 2000
2. Rapid Prototyping Materials, Gurumurthi, IISc Bangalore.
3. Rapid Automated, Lament wood. Indus press New York

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

CO1: Describe the fundamentals of rapid prototyping technology and classification of RP techniques to prepare prototypes for a different product.

CO2: Study RP techniques such as SLA, SLS, FDM, SGC, and LOM based on their applicability, materials used and advantages.

CO3: Specifically designed concept modelers can adopt to create various models quickly and inexpensively.

CO4: Apply rapid tooling technique for the different specified product easily.

CO5: Create RP models using different software tools. Analyze advanced RP techniques for their suitability and merits.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	2	1	1	1	1	2	1	1
CO2	3	3	2	3	1	1	1	2	1	1	1	2
CO3	3	3	3	2	2	1	1	1	2	1	1	1
CO4	3	3	3	1	2	1	1	1	1	2	1	2
CO5	3	3	2	2	1	1	1	1	2	1	1	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2018-19 **ACADEMIC YEAR: 2021-22**
SEMESTER : SEVENTH

COURSE TITLE : PROJECT MANAGEMENT (PROFESSIONAL ELECTIVE - 3)		
Sub Code: 18ME733	**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 : 50**
Pre-requisites	**Elementary knowledge of Calculus and Probability**	

Course Objective:

1. Describe Concepts of Project Management.
2. Prepare Scope Document and Communication Plan.
3. Demonstrate the skills, including Work Breakdown Structure and Draw up a plan.
4. Explain the principles of project scheduling tools and technique of project management.
5. Demonstrate Risk management and Understand Managing Projects.

UNITS	CONTENTS	Hrs.
UNIT- 1	**PROJECT MANAGEMENT CONCEPTS**	**07**
	Concepts of Project Management: Concepts of a project, Project Life Cycle, Project Governance, Phases of project life cycle, The need for Project Portfolio Management System.	
UNIT- 2	**DEFINING THE PROJECT**	**07**
	Defining the Scope, Establishing Project Priorities, preparation of Work Breakdown Structure (WBS), Responsibility Matrices, and Project Communication Plan. Feasibility study of a project.	
UNIT- 3	**PROJECT PLAN: NETWORK DIAGRAMS**	**08**
	Factors influencing Quality of Estimate, Methods of Estimation, Types of Costs. Developing Project Network, Simple Network Diagrams, Computation of Critical Path, Forward and Backward pass, Slack, Extended Network Techniques.(Simple numerical)	
UNIT- 4	**RESOURCE SCHEDULING**	**09**
	Types of Resource Constraints, Resource Allocation Methods, Splitting, Project Cost Baselines, Rationale and Options f or Accelerating Project Completion.(Simple numerical)	
UNIT- 5	**MANAGING PROJECTS AND RISKS**	**08**
	Five Stage Team Development Model, Project Team Pitfalls, Risk Management: Risk Identification, Risk assessment, Risk Response, Change Control Management.	

TEXT BOOKS:

1. Project Management, Clifford Grey, 6 Edition, Mcgraw Hill

REFERENCE BOOKS:

1. Project Management a System approach to planning Scheduling & Controlling-Harold Kerzner, 10th edition 2009, John wiley & sons.
2. Project Management –Bhavesh M.Patel, Vikas Publication House, 2002.

3. PERT & CPM. L.S. Srinath, Affiliated East West Press Pvt. Ltd 2002.
4. Project planning scheduling & control James P.Lawis, Meo Publishing Company, 5th edition 2010.

COURSE OUTCOMES: On completion of the course, student should be able to:
CO1: Appreciate the project management function in any organization.
CO2: Explain importance of scope, document and communication plan.
CO3: Explain importance of skills, including Work Breakdown Structure and Draw Up a Plan.
CO4: Explain various principles of project scheduling tools and technique of project management.
CO5: Explain Risk management and Understand Managing Projects.

MAPPING OF COs WITH POs												
COs/POs	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	0	2	0	0	0	0	0	0	2
CO2	3	3	2	1	2	0	2	0	0	0	0	2
CO3	3	3	2	1	2	0	0	0	0	0	0	2
CO4	3	3	3	3	2	2	0	0	0	2	0	2
CO5	3	3	2	1	3	3	3	0	0	2	0	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2018-19 **ACADEMIC YEAR: 2021-22**
SEMESTER : SEVENTH

COURSE TITLE: SOLAR THERMAL ENGINEERING (PROFESSIONAL ELECTIVE - 3)		
Sub Code: 18ME734	**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	**Elements of Mechanical Engineering**	

COURSE OBJECTIVES:

1. To provide opportunity for students to get acquainted on man, energy, thermal devices and applications.
2. To provide students with a sound foundation to formulate, solve and analyze basic solar radiation and its geometry.
3. To familiarize the students with liquid flat plate collector's energy balance and its performance affecting parameters.
4. To understand the concept of solar air heating and its thermal energy storage.
5. To impart the vital knowledge of concentrating collector technologies to suffice the present day energy crisis.

#	CONTENTS	Hrs.
UNIT-1	**INTRODUCTION**	**08**
	THE ENERGY SCENARIO: Man and Energy, World's Population and Reserves of Commercial Energy Sources, India's Production and Reserves, Energy Alternatives. THE SOLAR ENERGY OPTION - AN OVERVIEW OF THERMAL APPLICATIONS; Devices for Thermal Collection and Storage, Thermal Applications, Some Observations.	
UNIT-2	**SOLAR RADIATION**	**08**
	RADIATION – GENERAL: Solar Radiation Outside the Earth's Atmosphere, Solar Radiation at the Earth's Surface, Instruments for Measuring Solar Radiation and Sunshine, Solar Radiation Data. RADIATION – GEOMETRY; Solar Radiation Geometry, Empirical Equations for Predicting the Availability of Solar Radiation, Solar Radiation on Tilted Surfaces.	
UNIT-3	**LIQUID FLAT PLATE COLLECTORS**	**08**
	INTRODUCTION: General Performance Analysis, Transmissivity of the Cover System, Transmissivity-Absorptivity Product, Overall Loss Coefficient and Heat Transfer Correlations, Collector Efficiency and Heat Removal Factors. PERFORMANCE ANALYSIS; Effects of Various Parameters on Performance, Analysis of Collectors Similar to the Conventional Collector, Transient Analysis, Testing Procedures, Alternatives to the Conventional Collector.	
UNIT-4	**HEATING AND STORAGE**	**08**
	SOLAR AIR HEATERS; Introduction, Performance Analysis of A Conventional Air Heater, Other Types of Air Heaters, Testing Procedures. THERMAL ENERGY STORAGE; Introduction, Sensible Heat Storage, Latent Heat Storage, Thermochemical Storage.	
UNIT-5	**CONCENTRATING COLLECTORS**	**07**

	GENERAL; Introduction, Flat Plate Collectors with Plane Reflectors, Cylindrical Parabolic Collector. ADVANCED; Compound Parabolic Collector, Paraboloid Dish Collector, and Central Receiver Collector.	

TEXT BOOKS:

1. Solar Energy- Principles of thermal collection and storage, S.P Sukhatme and J.K. Nayak, 3rd Edition, 2009, Tata Mc-Graw Hill Publications.

REFERENCE BOOKS:

1. Solar Energy Utilization, G.D.Rai, 2004, Khanna Publishers.
2. Solar Engineering of thermal processes, Duffie, J.A. & Beckman, W.A., 4th Edition, 2013, John Wiley & Sons.

COURSE OUTCOMES (CO): On completion of the course, student should:

CO1: Identify the energy sources and its alternatives; understand the need for thermal devices and their applications.

CO2: Acquire knowledge of fundamentals of solar radiation measurements and its geometry.

CO3: Understand the principle of liquid flat plate collector and its performance affecting vital parameters.

CO4: Analyze the working principle of solar air heating and thermal energy storage

CO5: Describe the various types of concentrating collectors and their role in energy crisis solving.

MAPPING OF COs WITH POs												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	0	0	3	3	2	0	0	0	2
CO2	3	2	2	2	2	2	3	2	0	0	0	2
CO3	3	2	2	1	2	2	3	2	0	0	0	2
CO4	3	2	2	1	2	2	3	2	0	0	0	2
CO5	3	2	2	1	2	2	3	2	0	0	0	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not												

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 : 2020-21 ACADEMIC YEAR: 2021-22
SEMESTER : SEVENTH

COURSE TITLE : MECHANICS OF VISCOELASTIC MATERIALS		
Sub Code: 18ME735	**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, Engineering Chemistry, Material Science**	

COURSE OBJECTIVES:

1. Understanding the structure of Viscoelastic materials find applications in a wide variety of areas such as aerospace & surface transport components, sporting goods, consumer durables and biomedical implants.
2. The course will involve modelling and experimental aspects of the mechanics of viscoelastic materials.
3. Understanding the mechanics of these time-dependent materials is crucially important to engineers in many disciplines and provide the knowledge of viscoelastic measurements.
4. Understanding the transitions and relaxation processes in polymers.
5. The course contents are targeted towards a general understanding of the mechanics of viscoelastic materials with interdisciplinary emphasis. Students from different backgrounds such as from applied mechanics, aerospace, civil, chemical and mechanical engineering may find the course useful.

UNIT	CONTENTS	Hrs
UNIT-1	**INTRODUCTION**	**08**
	Introduction to Viscoelasticity, review of the structure of viscoelastic materials such as plastics, rubbers and biological tissues, Linear viscoelasticity, constitutive equations using mechanical analogs. **PHENOMENOLOGICAL TREATMENT OF VISCOELASTICITY** Elastic Modulus, Transient Experiments, Dynamic Experiments Boltzmann Superposition Principle, Relationship Between the Creep Compliance and the Stress Relaxation Modulus, Relationship Between Static and Dynamic Properties.	
UNIT-2	**VISCOELASTIC MODELS**	**07**
	Mechanical Elements, Maxwell Model, Voigt Model, Generalized Maxwell Model, Voigt-Kelvin Model, Distributions of Relaxation and Retardation Times, Molecular Theories, Application of Flexible-Chain Models to Solutions, The Zimm Modification, Extension to Bulk Polymer, Reptation.	
UNIT-3	**TIME TEMPERATURE CORRESPONDENCE & VISCOELASTIC MEASUREMENTS**	**08**
	Four regions of Viscoelastic behaviour, modulus-temperature curve of various regions of viscoelastic behaviour, Time-Temperature Superposition, Master Curves. **VISCOELASTIC MEASUREMENTS** Biomedical instrumentation provides the facilities of Biopac, ECG, EEG, EMG and heart rate variation recording system, Spirometer, Atria make ECG recording machine, Pulse oximeter.	
UNIT-4	**TRANSITIONS AND RELAXATION IN POLYMERS**	**08**
	Phenomenology of the Glass Transition, Theories of the Glass Transition, Free-Volume Theory, Thermodynamic Theory, Kinetic Theories, Structural Parameters Affecting the Glass Transition, Relaxations in the Glassy State, Relaxation Processes in Networks, Physical Relaxation, Chemical Processes.	

UNIT-5	DIELECTRIC AND NMR METHODS	08
	Dielectric Methods, Phenomenology, Molecular Interpretation of Dielectric Constant, Interfacial Polarization, Application to Polymers, Experimental Methods, Application of Dielectric Relaxation to Polymethyl Methacrylate, Comparisons Between Mechanical and Dielectric Relaxation for Polymers, Nuclear Magnetic Resonance Methods.	

TEXT BOOKS

1. M. T. Shaw and W. J. MacKnight, Introduction to Polymer Viscoelasticity, 3rd Ed., Wiley-Interscience, 2005.
2. I. M. Ward, J. Sweeny, The Mechanical Properties of Solid Polymers, 2nd Ed., Wiley, 2004.
3. A.S.Wineman and K.R.Rajagopal, Mechanical Response of Polymers: An Introduction, Cambridge University Press, 2000.
4. Handbook of Biomedical Instrumentation, R.S. Khandpur, McGraw-Hill Education, 1987 - Diagnostic imaging - 702 pages, 1 Review, Describing the physiological basis and engineering, principles of electro-medical equipment

REFERENCE BOOKS

1. E. Riande, R. Diaz-Calleja, M. G. Prolongo, R. M. Masegosa, C. Salom, Polymer viscoelasticity, CRC Press, 1999
2. W. N. Findley, J. S. Lai and K. Onaran, Creep and Relaxation of Nonlinear Viscoelastic Materials, Dover, 1989.
3. A. C. Pipkin, Lectures on Viscoelasticity Theory, 2nd Ed., Springer, 1986
4. R. M. Christensen, Theory of Viscoelasticity, Dover, 2nd Ed., 1982
5. J. D. Ferry, Viscoelastic Properties of Polymers, 3rd Ed., Wiley, 1980.

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

CO1: Analyze the structure of Viscoelastic materials such as plastics, rubbers and biological tissues.

CO2: Develop models for Viscoelastic materials.

CO3: Design experiments to characterize the mechanical response of viscoelastic materials and recognize measurements necessity.

CO4: Compile the transitions and relaxation processes in polymers.

CO5: Evaluate the mechanics of viscoelastic materials with interdisciplinary emphasis.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	2	1	1	1	1	2	1	1
CO2	3	3	2	3	1	1	1	2	1	1	1	2
CO3	3	3	3	2	2	1	1	1	2	1	1	1
CO4	3	3	3	1	2	1	1	1	1	2	1	2
CO5	3	3	2	2	1	1	1	1	2	1	1	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2018-19 **ACADEMIC YEAR: 2021-22**
SEMESTER : SEVENTH

COURSE TITLE : SMART MATERIALS (PROFESSIONAL ELECTIVE - 4)		
Sub Code: 18ME741	**No of Credits =03** **L-T-P-SS::3:0:0:0**	**No. of lecture hours/week : 03** **Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 100**
Pre-requisites	**Material Science, Composite Materials**	

COURSE OBJECTIVES:

1. The aim of this course is to integrate research results with curriculum development for the benefit of the students in physics, materials science and engineering civil and structural engineering, mechanical and aerospace engineering, industrial and systems engineering, as well as electrical and electronic engineering.
2. The fundamentals of smart materials, device and electronics, in particular those related to the development of smart structures and products.
3. The skills, knowledge and motivation in the design, analysis and manufacturing of smart structures and products.

#	CONTENTS	Hrs.
UNIT-1	**INTRODUCTION TO SMART MATERIALS**	**07**
	Characteristics of composites and ceramic materials, Smart materials and their types, dynamics and controls, concepts, Electro-magnetic materials and shape memory alloys-processing and characteristics.	
UNIT-2	**SMART STRUCTURES**	**08**
	Types of smart Structures, potential feasibility of smart structures, key elements of smart structures, applications of smart structures. Piezoelectric materials, properties, piezoelectric constitutive relations, poling and coercive field, field strain relation. Hysteresis, creep and strain rate effects, inchworm linear motor.	
UNIT-3	**SENSING AND ACTUATION**	**08**
	Principles of electromagnetic, acoustics, chemical and mechanical sensing and actuation, Types of sensors and their applications, signal processing, principals and characterization of sensors.	
UNIT-4	**SHAPE MEMORY ALLOY**	**08**
	Experimental Phenomenology, Shape Memory Effect, phase transformation, super elasticity, Tanaka's constitutive model, SME testing of SMA wires, vibration control through SMA, Testing of super elasticity, Applications Of SMA. **ER AND MR FLUIDS:** Mechanisms and properties, fluid composition and behavior, The Bingham plastic and related models, pre-yield response. Post-yield flow applications in clutches, dampers and others.	
UNIT-5	**VIBRATION ABSORBERS and MEMS**	**08**
	VIBRATION ABSORBERS: Series and parallel damped vibrations (overview), active vibration absorbers, fiber optics, physical phenomena, characteristics, sensors, fiber optics in crack detection, applications, biomimetics. **MEMS:** Mechanical properties of MEMS materials, scaling of mechanical systems, fundamentals of theory, the intrinsic characteristics of MEMS,	

	miniaturization, microelectronics integration.	

TEXT BOOKS:

1. **'Analysis and Design',** A. V. Srinivasan, 'Smart Structures –Cambridge University Press, New York, 2001, (ISBN : 0521650267)
2. **'Smart Materials and Structures',** M V Gandhi and B S Thompson Chapmen & Hall, London, 1992 (ISBN : 0412370107)

REFERENCE BOOKS:

1. **'Smart Materials and Structures',** Banks HT, RC Smith, Y Wang, Massow S A, Paris 1996
2. **G P Gibss'Adaptive Structures',** Clark R L, W R Saunolers, Jhon Wiles and Sons, New York, 1998
3. **An introduction for scientists and Engineers',**EsicUdd, Optic Sensors :Jhon Wiley & Sons, New York, 1991 (ISBN : 0471830070).

COURSE OUTCOMES: On completion of this COURSE, students should be able to:
CO1: Understand the physical principles underlying the behaviour of smart materials;
CO2: Analyze the properties of smart structures, Piezo electric materials with the applications and select suitable procedure for fabrication.
CO3: Understand the engineering principles in smart sensor, actuator and technologies
CO4: Explain the principle concepts of ER & MR Fluids and shape memory alloys with principles of working.
CO5: Describe the methods of controlling vibration using smart systems and fabrication methods of MEMS. Explain the principle concepts of Biomimetic, Fibre optics and actuation with principles of working.

MAPPING OF COs WITH POs												
COs/PO	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO1**	**PO1**	**PO1**
CO1	3	3	3	3	2	1	1	1	1	1	2	1
CO2	3	3	2	3	2	1	1	1	1	1	2	1
CO3	3	3	2	3	3	1	1	1	1	1	2	1
CO4	3	3	3	3	2	1	1	1	1	1	2	1
CO5	3	3	3	3	2	1	1	1	1	1	2	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not												

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: 2021-22**
SEMESTER : SEVENTH

COURSE TITLE : HIGH ENTROPY ALLOYS (PROFESSIONAL ELECTIVE - 4)		
Sub Code: 18ME742	**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 : 50**
Pre-requisites	**Elements of Mechanical Engineering**	

COURSE OBJECTIVES:

1. To provide opportunity for students to get acquainted with the history, birth and basic concepts of alloys.
2. To provide students with a sound foundation to formulate, solve and analyze phase selection and alloy design in the twenty first century.
3. To familiarize the students with synthesis, processing and solid solutions.
4. To understand the concept of intermetallic and interstitial compounds, metallic glasses and structural properties.
5. To impart the vital knowledge of functional properties, applications and future.

#	CONTENTS	Hrs.
UNIT-1	**HISTORY, BIRTH AND BASIC CONCEPTS OF ALLOYS**	**08**
	The coming of alloys, Special alloys, The coming of multicomponent HEAs, Classification of phase diagrams and alloy systems, Definition of HEAs, Composition of notations, Four core effects of HEAs	
UNIT-2	**PHASE SELECTION AND ALLOY DESIGN IN THE TWENTY FIRST CENTURY**	**08**
	ICME and materials genome strategies, Predicting solid solubility from Hume-Rothery rules, Mutual solubility and phase transformation tendency in HEAs, Parametric approaches to predict crystalline solid solution and metallic glass, Pettifor map approach to predict the formation of intermetallic compound, Quasicrystal and glass phase separation approach to find single phase HEAs, Integrated computational material engineering.	
UNIT-3	**SYNTHESIS, PROCESSING AND SOLID SOLUTIONS**	**08**
	Melting and casting route, Solid state processing route, HA and HEA based coatings, Combinatorial materials synthesis, Solid solution formation in equatomic HEAs, Solid solution formation in non-equatomic HEAs, Microstructure of HEAs, Role of sluggish diffusion in phase evolution of HEAs, Thermal stability of HEAs.	
UNIT-4	**INTERMETALLIC & INTERSTITIAL COMPOUNDS, METALLIC GLASSES AND STRUCTURAL PROPERTIES**	**08**
	Intermetallic compounds, Interstitial compounds (HAGG phases), Metallic glasses, Mechanical properties, Wear properties, Electrochemical properties, Oxidation behavior.	
UNIT-5	**FUNCTIONAL PROPERTIES, APPLICATIONS AND FUTURE**	08
	Diffusion barrier properties, Electrical properties, Thermal properties, Magnetic properties, Hydrogen storage properties, Irradiation resistance, Catalytic properties, Goals of property involvement, Advanced applications	

TEXT BOOKS:

1. High Entropy Alloys by B S Murthy, J W Yeh and S Ranganathan, Elsevier 2014, ISBN 978-0-12-800251-3

REFERENCE BOOKS:

2.High-Entropy Alloys-Fundamentals and Applications by Michael C Gao, Jien-Wei Yeh, Peter K Liaw, Yong Zhang, Springer, ISBN 978-3-319-27011-1

COURSE OUTCOMES (CO): On completion of the course, student should:

CO6: Identify the history, birth and basic concepts of alloys.

CO7: Acquire knowledge of fundamentals of phase selection and alloy design in the twenty first century

CO8: Understand the principles of synthesis, processing and solid solutions

CO9: Analyze the working principle of intermetallic and interstitial compounds, metallic glasses and structural properties

CO10: Describe the various types of functional properties, applications and future.

MAPPING OF COs WITH POs												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	0	0	3	3	2	0	0	0	2
CO2	3	2	2	2	2	2	3	2	0	0	0	2
CO3	3	2	2	1	2	2	3	2	0	0	0	2
CO4	3	2	2	1	2	2	3	2	0	0	0	2
CO5	3	2	2	1	2	2	3	2	0	0	0	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2018-19 **ACADEMIC YEAR: 2021-22**
SEMESTER : SEVENTH

COURSE TITLE: TRIBOLOGY AND BEARING DESIGN (PROFESSIONAL ELECTIVE - 4)		
Sub Code: 18ME743	**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 : 50**
Pre-requisites	**Fluid Mechanics, KOM, DOM**	

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 Tribology**: Introduction, Friction, Wear, Wear Characterization, Regimes of lubrication Classification of contacts, lubrication theories, Effect of pressure and temperature on viscosity. Newton's Law of viscous forces, Flow through stationary parallel plates. Hagen's Poiseuille's theory, viscometers. Numerical problems, Concept of lightly loaded bearings, Petroff's equation, Numerical problems.	**07**
UNIT-2	**Hydrodynamic Lubrication**: Pressure development mechanism. Converging and diverging films and pressure induced flow. Reynold‟s equation in two dimensions with assumptions. Introduction to idealized slide bearing with fixed shoe and Pivoted shoes. Expression for load carrying capacity. Location of center of pressure, effect of end leakage on performance, Numerical problems **Journal Bearings:** Introduction to idealized full journal bearings. Load carrying capacity of idealized full journal bearings, Sommerfeld number and its significance, short and partial bearings, Comparison between lightly loaded and heavily loaded bearings, effects of end leakage on performance, Numerical problems.	**08**
UNIT-3	**Hydrostatic Bearings**: Hydrostatic thrust bearings , hydrostatic circular pad, annular pad, rectangular pad bearings, types of flow restrictors, expression for discharge, load carrying capacity and condition for minimum power loss, numerical problems, and hydrostatic journal bearings. **EHL Contacts**: Introduction to Elasto - hydrodynamic lubricated bearings. Introduction to 'EHL' constant. Grubin type solution.	**08**
UNIT-4	**Antifriction bearings**: Advantages, selection, nominal life, static and dynamic load earing capacity, probability of survival, equivalent load, cubic mean load, bearing Mountings. **Porous Bearings:** Introduction to porous and gas lubricated bearings. Governing differential equation for gas lubricated bearings, Equations for porous bearings and working principal, Fretting phenomenon and its stages.	08

UNIT-5	**Magnetic Bearings:** Introduction to magnetic bearings, Active magnetic bearings. Different equations used in magnetic bearings and working principal. Advantages and disadvantages of magnetic bearings, Electrical analogy, Magneto-hydrodynamic bearings.	08

TEXT BOOKS:

1. Mujamdar.B.C "Introduction to Tribology of Bearing", Wheeler Publishing, New Delhi 2001
2. Radzimovsky, "Lubrication of Bearings - Theoretical principles and design" Oxford press Company, 2000.

REFERENCE BOOKS

1. Dudley D.Fulier “Theory and practice of Lubrication for Engineers", New York Company.1998
2. Moore "Principles and applications of Tribology", Pergamon press, 1975.
3. Oscar Pinkus, BenoSternlicht, “Theory of hydrodynamic lubrication”, McGraw-Hill, 1961.
4. G W Stachowiak, A W Batchelor ,“Engineering Tribology”, Elsevier publication 1993.
5. Hydrostatic and hybrid bearings, Butterworth 1983.
6. F. M. Stansfield, Hydrostatic bearings for machine tools and similar applications, Machinery Publishing, 1970.

COURSE OUTCOMES (CO):

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	0	0	3	3	2	0	0	0	2
CO2	3	2	2	2	2	2	3	2	0	0	0	2
CO3	3	2	2	1	2	2	3	2	0	0	0	2
CO4	3	2	2	1	2	2	3	2	0	0	0	2
CO5	3	2	2	1	2	2	3	2	0	0	0	2
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										

ADMISSION YEAR : 2018-19 **ACADEMIC YEAR: 2021-22**
SEMESTER : SEVENTH

COURSE TITLE: POWER PLANT ENGINEERING (PROFESSIONAL ELECTIVE - 4)		
Sub Code: 18ME744	**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**	**SEE Marks: 50**
Pre-requisites	**EME, Engineering Mathematics**	

COURSE OBJECTIVES:

1. To familiarize with Energy policy of India and trends of energy generation
2. To demonstrate layout and components of steam power plants, diesel engine power plants, hydroelectric power plants, and nuclear power plants.
3. To implement principles of power generation through solar energy, wind energy, ocean, tidal energy & fuel cells.
4. To apply basic calculations to understand design principles of conventional energy conversion.
5. To demonstrate competence in understanding performance of energy conversion devices through experiments.

#	CONTENTS	Hrs.
UNIT-1	**ECONOMICS OF POWER GENERATION**	**08**
	Introduction, Energy policy of India, Terms and Definition: Connected load, Demand, Maximum load or peak load, Demand facto, Load factor, Diversity factor, Utilization factor, Plant capacity factor, Plant use factor, Types of load, Load curves, Load duration curve, etc., Principles of power plant design ,Location of power plant, Cost analysis, Selection of type of generation, Selection of power plant equipment, Economics in plant selection, Factors affecting economics of generation and distribution of power, Performance and operating characteristics of power plant. Economic load sharing, Tariff for electrical Energy, Numerical.	
UNIT-2	**THERMAL POWER PLANTS**	**08**
	Introduction: Energy sources for generation of electric power, present status and future trends, Thermal Power Plants: Selection of site, general layout of the plant, major components- Boilers, Economizers, Super-heaters, Air pre-heaters, fuels, principle of fuel burning, pulverizing of fuels and burning, fuel and ash handling equipment, High pressure Boilers, steam turbines, station heat balance and plant efficiency.	
UNIT-3	**DIESEL ENGINE POWER PLANT**	**08**
	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.	
	HYDROELECTRIC POWER PLANTS	
	Introduction; Classification of hydro-plants, selection of site, rain fall and run off calculation of storage capacity, plant layout estimation of power available,	

	selection of hydraulic turbines and their governing, general layout of hydro power plant.	
UNIT-4	**NUCLEAR POWER PLANT**	**08**
	Nuclear Power Plants: Introduction, Atomic structure and radio-activities nuclear reactions, binding energy, Nuclear Reactors, Types of reactors, Pressurized water reactors, boiling heater reactors, Heavy water-cooled and moderated (CANDU) reactor, Gas cooled reactors, Liquid metal cooled reactors, Indian Nuclear power installations, comparison between Nuclear and Thermal plants, Numericals.	
UNIT-5	**NON CONVENTIONAL POWER GENERATION**	**07**
	Introduction, Direct energy conversion, MHD, Thermionic and Thermoelectric power generation, Fuel cells, Geothermal energy, Hydrogen energy systems, Numericals.	

TEXT BOOKS

1. Power Plant Engineering, P. K. Nag, Tata McGraw Hill, 4 Edition, 2014.

2. A Text Book of Power Plant Engineering, R. K. Rajput, Laxmi publication, New Delhi, 4 Edition, 2007.

REFERENCE BOOKS

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

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

CO1: Know the sources of energy, energy generation by coal and the systems needed for its function.

CO2: Learn the layout, Applications and components of Diesel power plants

CO3: Study Hydrology, required flow graphs for calculating the capacity, site selection and different components of hydroelectric power plant

CO4: Explain nuclear materials, principles of energy release and components of reactors and different types of nuclear reactors and nuclear waste disposal

CO5: Study the different nonconventional energy conversion methods for power generation.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	1	1	1	1	1	1	1	1
CO2	3	3	2	1	1	1	1	1	1	1	1	1
CO3	3	3	3	1	1	1	1	1	1	1	1	1
CO4	3	3	2	1	1	1	1	1	1	1	1	1
CO5	3	3	3	1	1	1	1	1	1	1	1	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

ADMISSION YEAR : 2018-19 **ACADEMIC YEAR: 2021-22**
SEMESTER : SEVENTH

COURSE TITLE : COMPUTATIONAL FLUID DYNAMICS (PROFESSIONAL ELECTIVE - 4)		
Sub Code: 18ME745	**No of Credits : L-T-P-SS 03:00:00:00 =03**	**No. of lecture hours/week : 03 Total Number of Lecture hours : 39**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**
Pre-requisites	**Fluid dynamics, Mathematics**	

COURSE OBJECTIVES:

1. To understand the fundamentals of CFD and fluid flow equations in conservation forms.
2. To understand the various methods of solving linear algebraic equations.
3. To know the discretization methods and understand how it can be used in heat conduction problems.
4. To know the equations related to convection and diffusion and understand the methods to solve these equations.
5. To understand the Navier Stokes equations and turbulent modeling.

	CONTENTS	**Hrs**
UNIT-1	**INTRODUCTION TO COMPUTATIONAL FLUID DYNAMICS**	**07**
	Computational Fluid Dynamics: What, When, and Why?, CFD Applications, Experimental investigations, theoretical calculations, advantages and disadvantages of theoretical calculations, Fundamental principles of conservation, Reynolds transport theorem, Conservation of mass, Conservation of momentum, Conservation of Energy equations, Navier-Stokes equation, Time-average equations for turbulent flow, the turbulent kinetic energy equation, the general differential equations, Nature of coordinates : Independent variables, choice of coordinates, one way and two way coordinates.	
UNIT-2	**DISCRETISATION METHODS**	**08**
	The Discretization concept, The structure of Discretization equation, Methods of deriving the Discretization equation: Taylor series formulation, variation formulation, method of Weighted residuals, Control Volume formulations. Illustrative examples, Four basic rules, Numerical problems.	
UNIT-3	**HEAT CONDUCTION**	**08**
	Heat conduction: Steady one dimensional Conduction: The basic Equation, The grid Spacing, The interface conductivity, Non linearity, Source term Linearization, Boundary conditions, Unsteady one dimensional Conduction: the general Discretization equation, Explicit, Crank Nicolson and fully implicit schemes, Two dimensional and three dimensional situation, Over relaxation and Under relaxation Methods. Problems.	
UNIT-4	**CONVECTION AND DIFFUSION**	**08**
	Steady one dimensional Convection and diffusion, the primary derivation, the upwind scheme, the exact solution, The Exponential scheme, The Hybrid scheme, The power law scheme, consequences of various scheme, Discretization equation for Two dimension, details of derivation, final Discretization equation, Discretization equation for Three dimension, one way space coordinates, outflow boundary conditions, False diffusion: common and proper view of False diffusion.	

UNIT-5	NAVIER STOKES EQUATIONS AND TURBULENT MODELLING	08
	Discretization of the Momentum Equation: Stream Function-Vorticity approach and Primitive variable approach, Staggered grid and Collocated grid, SIMPLE Algorithm, SIMPLER Algorithm, Important features of turbulent flow, Vorticity transport equation, Statistical representation of turbulent flows: Homogeneous turbulence and isotropic turbulence, General Properties of turbulent quantities, Reynolds average Navier stokes (RANS) equation, Closure problem in turbulence: Necessity of turbulence modeling, Different types of turbulence model: Eddy viscosity 2 models, Mixing length model, The κ-ε model, Advantages and disadvantages of κ -ε model	

TEXT BOOKS:

1. **Computational Fluid Dynamics: The Basics with Applications,** John D. Anderson, Jr., McGraw-Hill International Editions, 1995.
2. **Computational Fluid Flow and Heat Transfer,** K. Muralidhar and T.Sundararajan (Editors), 2nd Edition, Narosa Publishing House, 2003.
3. **Introduction to Computational Fluid Dynamics:** H.K. Versteeg and W. Malalasekera, Pearson Education Limited, 2nd Edition, 2007.

REFERENCE BOOKS:

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

e-LEARNING RESOURCES

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

COURSE OUTCOME (CO)

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

CO1: Understand the fundamental concepts of computational fluid dynamics and explain Reynolds transport theorem.

CO2: Understand the concept of Discretization and its methods;

CO3: Discretize the heat conduction equations and solve numerical problems.

CO4: Derive the one dimensional steady convection and diffusion equation; Discretize these equations using different methods.

CO5: Discretize the momentum equation and understand the various turbulent models.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	1	1	1	1	1	1	1	1
CO2	3	3	2	1	1	1	1	1	1	1	1	1
CO3	3	3	3	1	1	1	1	1	1	1	1	1
CO4	3	3	2	1	1	1	1	1	1	1	1	1
CO5	3	3	3	1	1	1	1	1	1	1	1	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

QUESTION PAPER PATTERN (SEE)										
Q. No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
UNIT	1		2		3		4		5	
1. Two full questions (each of 20 Marks) are to be set from each unit.										
2. Student shall answer five full questions selecting one full question from each unit.										
3. Each full question shall have maximum of 3 sub-divisions.										

ADMISSION YEAR : 2018-19 ACADEMIC YEAR: 2021-22
SEMESTER : SEVENTH

COURSE TITLE : DESIGN LABORATORY		
Sub Code: 18MEL76	**No of Credits =01 L-T-P-SS::0:0:2:0**	**No. of lecture hours/week : 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**
Pre-requisites	**Design of Machine Elements**	

COURSE OBJECTIVES:

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

UNITS	**CONTENTS**	**Hrs**
UNIT-1	1. Experimental prediction of natural frequency of compound pendulum, prediction of equivalent simple pendulum system. 2. Experimental prediction of natural frequency for longitudinal vibrations of helical springs, and springs in series and parallel with or without damping and Torsional Vibration. 3. Experimental prediction of natural frequencies, and nodal points for single rotor and two-rotor vibratory system, and comparison with theoretical results 4. Experimental and theoretical investigation of whirling of shaft (i.e. . comparison of experimental and theoretical natural frequency and justification of discrepancy between experiment and theory) 5.Determination of Fringe constant of Photo elastic material using (a) Circular disc subjected to diametric compression (b) Pure bending specimen (four point bending).(c) Tensile specimen. 6.Determination of stress concentration using Photo elasticity for simple components like circular disk with circular hole under diametrical compression,	**18**
UNIT-2	1. Determination of centrifugal force, power, effort, range speed sensitiveness of Porter/ Watt /Hartnel Governor. (Only one or more). 2. Determination of Principal Stresses and strains young's modulus in a member to tensile/combined loading using Strain rosettes. 3. Experiments on Gyroscope.	**08**

REFERENCE BOOKS :

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

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

CO1: To exposure the students get to the modern design experimental techniques and instrumentation.
CO2: Understand the essence of kinetics and dynamics through experiments.
CO3: Visualize the stresses developed in an object through photo elasticity implementation of concept of stress concentration in design.
CO4: Have potential to design the experimentation as per need.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	2	1	1	2	2	3	3	1	2
CO2	2	3	3	2	1	1	2	2	3	3	1	2
CO3	3	3	3	2	1	1	2	2	3	2	1	2
CO4	3	3	2	2	1	1	2	2	2	2	1	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not												

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

Change of experiment is not permitted if change of experiment permitted, that experiment is evaluated for 50% marks of allotted marks.

ADMISSION YEAR : 2018-19 ACADEMIC YEAR: 2021-22
SEMESTER : SEVENTH

COURSE TITLE : COMPUTER AIDED MODELING AND ANALYSIS LABORATORY		
Sub Code: 18MEL77	**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**	**SEE Marks : 50**
Pre-requisites	**Engineering Mathematics, MOM, DME**	

COURSE OBJECTIVES:

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

#	Contents	Hrs
UNIT-1	**A MODELING STRESS AND ANALYSIS USING FEA PACKAGE**	**13**
	a. Analysis of 1D structural members and verification of the same through manual calculation. b. Bars of constant cross section area, tapered cross section area and stepped bar c. Trusses – (Minimum 2 exercises) d. Beams – Simply supported, cantilever, beams with UDL, beams with varying load etc. (Minimum 6 exercises) e. Includes Theoretical problems and Introduction to meshing	
UNIT-2	**STRESS ANALYSIS OF**	**13**
	a) 2D Stress analysis of a rectangular plate subjected different loads b) Determining of stress concentration factor for rectangular plate with circular cut out and square cutout c)Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions(Minimum 4 exercises) d) Dynamic Analysis 1) Fixed – fixed beam for natural frequency determination 2) Bar subjected to forcing function 3) Fixed – fixed beam subjected to forcing function	

REFERENCE BOOKS:

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

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

CO1: Do 3D/2D Modelling and assign the material properties of the models.
CO2: Do proper meshing of the modelled component with different meshing techniques, mesh size control and mesh quality check.
CO3: Assign the required boundary condition, loading condition, types of loading and solve.
CO4: To analyze and evaluate the results obtained after analysis.

MAPPING OF COs WITH POS												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	2	2	3	3	2	3	3	0	2

CO2	2	3	3	2	2	1	3	2	3	3	0	2
CO3	3	3	3	2	3	2	3	1	3	2	0	2
CO4	3	3	2	2	3	2	3	1	2	2	0	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

SCHEME OF EXAMINATION (SEE)					
Sl. No.	**Particulars**	**Max. Marks**	**Break Up of Max. Marks**		
			Write Up	**Conduction of experiment / Modelling Analysis**	**Expected Out Putt-Results (Different displacement, BM, Stress, Strain results. Etc. and Plotting deformation diagram, SFD,BMD, Graph if it's required)**
1	**Unit-1: Minor Experiment** (Any ONE from the list of experiments and it is purely individual Experiment) Q1	**20**	05	05	10
2	**Unit-2: Major Experiment** (Any ONE **Experiment** from the list of experiments and it is a Group Experiment) Q2	**20**	05	5	10
3	Viva Voce	**10**	--	--	--
TOTAL MARKS		**50**			

ADMISSION YEAR : 2018-19 ACADEMIC YEAR: 2021-22
SEMESTER : SEVENTH

COURSE TITLE : PROJECT WORK PHASE- I		
Sub Code: 18MEP78	**No of Credits =2 L-T-P-SS:: 0:0:4:0**	**No. of contact hours/week : 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE 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.

STAGES FOR PROJECT WORK	
Step 1	Formulation of the problem
Step 2	Exhaustive literature survey
Step 3	Methodology
Step 4	Time estimation for completing the project

The Project proposal shall be submitted within 3 weeks from the start of the semester in the prescribed standard format (04 copies) to the HOD, after the certification of the concerned guide and HOD.

Minimum number of students per batch: 02 Maximum number of students per batch: 04

CIE Evaluation: Two seminars shall be conducted at the end of 6 and 10 week of the semester.

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

CO1: Literature review on par with international journal standards

CO2: Literature gap determination and definition of the problem

CO3: Scientific Design / Numerical Analysis / Analytical model and interpret them

CO4: Apply tools / techniques for problem solving and prepare project work

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	2	1	1	1	1	1	1	1
CO2	3	3	2	1	2	1	1	1	1	2	1	1
CO3	3	3	2	1	2	1	1	1	1	2	1	1
CO4	3	3	3	1	2	1	1	1	1	2	1	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

SCHEME OF EXAMINATION (CIE)

1. Departments shall constitute a Departmental Project Review Committee (internal guide + faculty) to review the project at the middle of the semester.
2. Internal guide alone shall evaluate the Project Phase I at the end of the semester for a maximum of 35 marks.
3. Project Review Committee shall evaluate the Project Phase I at the end of the semester for a maximum of 15 marks.

SCHEME OF EVALUATION (CIE)			
PARTICULARS	**Guide (MAX MARKS)**	**Project Review Committee (MAX MARKS)**	**Total Marks**
Formulation of the problem		**03**	
Relevance of the subject in the present context		**02**	
Literature Survey		**02**	
Problem formulation		**03**	
Oral presentation		**05**	
TOTAL	**35**	**15**	**50**

SCHEME OF EVALUATION (SEE)	
Sl. No.	**PARTICULARS**
1	Formulation of the problem
2	Relevance of the subject in the present context
3	Literature Survey
4	Problem formulation
5	Oral presentation

GUIDELINES FOR PREPARING PROJECT REPORT

1. Project reports should be typed neatly only on one side of the paper with 1.5 or double line spacing on an A4 size bond paper (210 x 297 mm).
2. **The margins should be:** Left – 1.25″, Right – 1″, Top and Bottom – 0.75″.
3. The total number of reports to be prepared are
   i) A copy to the department library
   ii) A copy to the concerned guide(s)
   iii) Two copies to the sponsoring agency
   iv) Candidate's copy.
4. Before taking the final printout, the approval of the **concerned guide(s) is mandatory** with suggested corrections, if any, to be incorporated.
5. For making copies dry tone Xerox is suggested. Every copy of the report must contain Inner title page (White) Outer title page with a plastic cover Certificate in the format enclosed both from the college and the organization where the project is carried out.
6. An **abstract (synopsis)** not exceeding 100 words, indicating salient features of the work. (NB: four copies of the abstract are to be submitted to the Department on the date of submission separately)
7. The organization of the report should be as follows
   i) Inner title page
   ii) Abstract or Synopsis
   iii) Acknowledgments
   iv) Table of Contents
   v) List of table & figures (optional)
   vi) Usually numbered in roman

vii) Chapters (to be numbered in Arabic) containing Introduction-, which usually specifies the scope of work and its importance and relation to previous work and the present developments, Main body of the report divided appropriately into chapters, sections and subsections.

viii) The chapters, sections and subsections may be numbered in the decimal form for e.g. Chapter 2, sections as 2.1, 2.2 etc., and subsections as 2.2.3, 2.5.1 etc.

ix) The chapter must be left or right justified (font size 16). Followed by the title of chapter centered (font size 18), section/subsection numbers along with their headings must be left justified with section number and its heading in font size 16 and subsection and its heading in font size 14. The body or the text of the report should have font size 12.

x) The figures and tables must be numbered chapter wise for e.g.: Fig. 2.1 Block diagram of a serial binary adder, Table 3.1 Primitive flow table, etc.

xi) The last chapter should contain the summary of the work carried, contributions if any, their utility along with the scope for further work.

xii) **Reference OR Bibliography:** The references should be numbered serially in the order of their occurrence in the text and their numbers should be indicated within square brackets for e.g. [3]. The section on references should list them in serial order in the following format.

For textbooks – A.V. Oppenheim and R.W. Schafer, Digital Signal Processing, Englewood, N.J., Prentice Hall, 3 Edition, 1975.

For papers – Devid, Insulation design to combat pollution problem, Proc of IEEE, PAS, Vol 71, Aug 1981, pp 1901-1907.

8. Only SI units are to be used in the report. Important equations must be numbered in decimal form for e.g.

$$V = IZ \text{ ……. } (3.2)$$

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

COLOUR OF THE OUTER COVER/FRONT PAGE OF UG DISSERTATION / PROJECT REPORT - SKY BLUE

Dr. AMBEDKAR INSTITUTE OF TECHNOLOGY

(An autonomous institution, Aided by Govt. of Karnataka, Affiliated to VTU)
BDA Outer Ring Road, Near Jnana Bharathi Campus, Bengaluru - 560056

Aided By Govt. of Karnataka

Department of Mechanical Engineering

CERTIFICATE

Certified that the project work - Phase I (Seventh Semester) entitled…… is carried out by the following bonafide students of Mechanical Engineering in partial fulfilment for the award of Bachelor of Engineering, B. E (Mechanical) at **Dr. Ambedkar Institute of Technology, Bangalore,** during the academic year ..... .

Sl. No	U S N (ascending order)	Name of Student

It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the project report.

The project report has been approved satisfying the academic requirements prescribed for the said Degree.

Guide	**Internal Examiner**	**HOD**

ADMISSION YEAR: 2018-19 **ACADEMIC YEAR: 2021-22**

SEMESTER : SEVENTH

COURSE TITLE : INDUSTRY INTERNSHIP	
Sub Code: 18MEI79	**No of Credits =00** **L-T-P-SS::0:0:2:0**

Internship: All the students admitted to III year of BE/B. Tech have to undergo mandatory internship of 4 weeks during the vacations of VI and VII semesters and /or VII and VIII semesters. If not completed after VI semester examinations, it has to be carried out during the intervening vacations of VII and VIII semesters). A University examination will be conducted during VIII semester and prescribed credit are added to VIII semester. Internship is considered as a head of passing and is considered for the award of degree. Those, who do not take-up/complete the internship will be declared as failed and have to complete during subsequent University examination after satisfy the internship requirements.

OBJECTIVE:

1. To inculcate the working procedure in the students in the industry by incorporating their knowledge gained during engineering course.
2. Exposing the student community to the real working environment in the industry.

PROCEDURE FOR INTERNSHIP:

1. Students shall approach any one of small, medium or large scale industries of their choice and get permission for carryout internship for a minimum duration of four weeks.
2. Obtain a permission/recommendation letter from the college to the respective industry to permit him/her to carry out the internship.
3. After obtaining a permission from industry, fix the time period for internship (during their intervening vacations of VII and VIII semester) after mutual discussion with the industry and the students. The same should be communicated to the department regarding the time period of internship.
4. Student should start and continue his/her internship with the assistance and guidance of the allotted authorised person to gain maximum knowledge of real time working in the industry.
5. Student should maintain a fact sheet of working (containing timings, machines, operations, softwares, programmes etc.) on day to day basis for his/her entire period of internship.
6. Obtain a signature in all the fact sheet from the authorised person under whom guidance he/she is working.
7. An internship certificate issued by that industry should be obtained and submitted to the department.
8. Immediately after completion of the internship he/she must prepare an internship report containing internship certificate and submit the report to the department for evaluation.

ADMISSION YEAR : 2018-19 **ACADEMIC YEAR: 2021-22**
SEMESTER : EIGHTH

COURSE TITLE : PROJECT WORK PHASE – II		
Sub Code: 18MEP81	**No of Credits : 10**	**No. of contact hours/week : 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**

COURSE OBJECTIVES:

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

STAGES OF PROJECT WORK
Identification of project topic related to area of interest in the field of advanced or current mechanical engineering
Literature survey based on the identified topic
Define / formulate the problem and the methodology
Design and fabricate or analysis based on type of problem
Results, conclusions, scope for further work
References.
Oral presentation of the project at the end of 6^{th} and 10^{th} week of a semester

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

CO1: Perform literature review on par with international journal standards.

CO2: Identify literature gap and define the problem.

CO3: Design experiments scientifically / perform numerical analysis / develop analytical models and interpret the results and apply advanced tools / techniques for solving the problem.

CO4: Prepare quality document of project work.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	1	1	3	3	2	3	1
CO2	3	3	2	3	3	1	1	3	3	2	3	2
CO3	3	3	3	3	3	1	1	3	3	2	3	2
CO4	3	3	2	1	3	1	1	2	2	3	3	1
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

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

SCHEME OF EVALUATION (CIE)			
PARTICULARS	**Guide (MAX MARKS)**	**Project Review Committee (MAX MARKS)**	**Total Marks**
Relevance of topic		**05**	
Oral presentation		**05**	
Viva Voce		**05**	
TOTAL	**35**	**15**	**50**

SCHEME OF EVALUATION (SEE)		
Sl. No.	**Particulars**	**Max. Marks**
1	Relevance of the subject in the present context	**05**
2	Literature Survey	**05**
3	Problem formulation	**05**
4	Experimental observation / theoretical modelling	**05**
5	Results – Presentation & Discussion	**05**
6	Conclusions and scope for future work	**05**
7	Overall presentation of the Thesis/Oral presentation	**20**
	Total Marks	**50**

GUIDELINES FOR PREPARING PROJECT REPORT

8. Project reports should be typed neatly only on one side of the paper with 1.5 or double line spacing on an A4 size bond paper (210 x 297 mm).
9. **The margins should be:** Left – 1.25″, Right – 1″, Top and Bottom – 0.75″.
10. The total number of reports to be prepared are
    v) A copy to the department library
    vi) A copy to the concerned guide(s)
    vii) Two copies to the sponsoring agency
    viii) Candidate's copy.
11. Before taking the final printout, the approval of the **concerned guide(s) is mandatory** with suggested corrections, if any, to be incorporated.
12. For making copies dry tone Xerox is suggested. Every copy of the report must contain Inner title page (White) Outer title page with a plastic cover Certificate in the format enclosed both from the college and the organization where the project is carried out.
13. An **abstract (synopsis)** not exceeding 100 words, indicating salient features of the work. (NB: four copies of the abstract are to be submitted to the Department on the date of submission separately)
14. The organization of the report should be as follows
    xiii) Inner title page
    xiv) Abstract or Synopsis
    xv) Acknowledgments
    xvi) Table of Contents
    xvii) List of table & figures (optional)
    xviii) Usually numbered in roman
    xix) Chapters (to be numbered in Arabic) containing Introduction-, which usually specifies the scope of work and its importance and relation to previous work and

the present developments, Main body of the report divided appropriately into chapters, sections and subsections.

xx) The chapters, sections and subsections may be numbered in the decimal form for e.g. Chapter 2, sections as 2.1, 2.2 etc., and subsections as 2.2.3, 2.5.1 etc.

xxi) The chapter must be left or right justified (font size 16). Followed by the title of chapter centered (font size 18), section/subsection numbers along with their headings must be left justified with section number and its heading in font size 16 and subsection and its heading in font size 14. The body or the text of the report should have font size 12.

xxii) The figures and tables must be numbered chapter wise for e.g.: Fig. 2.1 Block diagram of a serial binary adder, Table 3.1 Primitive flow table, etc.

xxiii) The last chapter should contain the summary of the work carried, contributions if any, their utility along with the scope for further work.

xxiv) **Reference OR Bibliography:** The references should be numbered serially in the order of their occurrence in the text and their numbers should be indicated within square brackets for e.g. [3]. The section on references should list them in serial order in the following format.

For textbooks – A.V. Oppenheim and R.W. Schafer, Digital Signal Processing, Englewood, N.J., Prentice Hall, 3 Edition, 1975.

For papers – Devid, Insulation design to combat pollution problem, Proc of IEEE, PAS, Vol 71, Aug 1981, pp 1901-1907.

9. Only SI units are to be used in the report. Important equations must be numbered in decimal form for e.g.

$$V = IZ \text{ ……. } (3.2)$$

All equation numbers should be right justified.

16. The project report should be brief and include descriptions of work carried out by others only to the minimum extent necessary. Verbatim reproduction of material available elsewhere should be strictly avoided. Where short excerpts from published work are desired to be included, they should be within quotation marks appropriately referenced.

    Proper attention is to be paid not only to the technical contents but also to the organization of the report and clarity of the expression. Due care should be taken to avoid spelling and typing errors. The student should note that report-write-up forms the important component in the overall evaluation of the project

17. Hardware projects must include: the component layout, complete circuit with the component list containing the name of the component, numbers used, etc. and the main component data sheets as Appendix.
18. At the time of report submissions, the students must hand over a copy of these details to the project coordinator and see that they are entered in proper registers maintained in the department.
19. Software projects must include a virus free disc, containing the software developed by them along with the read me file. Read me file should contain the details of the variables used, salient features of the software and procedure of using them: compiling procedure, details of the computer hardware/software requirements to run the same, etc. If the developed software uses any public domain software downloaded from some site, then the address of the site along with the module name etc. must be included on a separate sheet. It must be properly acknowledged in the acknowledgments.

20. Sponsored Projects must also satisfy the above requirements along with statement of accounts, bills for the same dully attested by the concerned guides to process further, They must also produce NOC from the concerned guide before taking the internal viva examination.
21. The reports submitted to the department/guide(s) must be hard bounded, with a plastic covering.
22. Separator sheets, used if any, between chapters, should be of thin paper

COLOUR OF THE OUTER COVER/FRONT PAGE OF UG DISSERTATION / PROJECT REPORT - SKY BLUE

Dr. AMBEDKAR INSTITUTE OF TECHNOLOGY

(An autonomous institution, Aided by Govt. of Karnataka, Affiliated to VTU)
BDA Outer Ring Road, Near Jnana Bharathi Campus, Bengaluru - 560056

Aided By Govt. of Karnataka

Department of Mechanical Engineering

CERTIFICATE

Certified that the project work - Phase II (Eighth Semester) entitled…… is carried out by the following bonafide students of Mechanical Engineering in partial fulfilment for the award of Bachelor of Engineering, B. E (Mechanical) at **Dr. Ambedkar Institute of Technology, Bangalore,** during the academic year ..... .

Sl. No	**U S N** (ascending order)	**Name of Student**

It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the project report.

The project report has been approved satisfying the academic requirements prescribed for the said Degree.

Guide	**HOD**	**Principal**

External Viva:

Sl. No	Name of the examiner	Signature with date
1		
2		

ADMISSION YEAR: 2018-19 **ACADEMIC YEAR: 2021-22**

SEMESTER : EIGHTH

COURSE TITLE : TECHNICAL SEMINAR		
Sub Code: 18MES82	**No of Credits : 02**	**No. of contact hours/week : 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**

COURSE OBJECTIVES:

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

STAGES OF SUBJECT SEMINAR
Identification of seminar topic related to area of interest in the field of advanced mechanical engineering.
Literature survey on the selected topics and collection of research papers.
Final seminar shall be presented during 8 /9 week of the semester in the department before the Departmental Evaluation Committee constituted by HOD.
The seminar marks are to be awarded by the committee.
Students shall submit the seminar report in the prescribed standard format.

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

CO1: Conduct literature survey on a current topic based on peer reviewed literature and identify research gap in the literature

CO2: Develop methodologies to resolve the identified problem(s)

CO3: Develop presentation slides / report arranging the material coherently and discuss the topic with clarity and confidence.

CO4: Summarize the presentation, submit the report and identify scope for further work.

MAPPING OF COs WITH POs												
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	2	3	3	3	3	3
CO2	3	3	2	3	3	3	2	3	3	3	3	3
CO3	3	3	3	3	3	3	2	3	3	3	3	3
CO4	3	3	2	1	3	3	3	3	3	3	3	3
Strength of correlation: Strongly related-3, Moderately related-2, Weakly related-1, Not related-0												

SCHEME OF EVALUATION (CIE)			
PARTICULARS	**Guide (MAX MARKS)**	**Project Review Committee (MAX MARKS)**	**Total Marks**
Relevance of topic		**05**	
Oral presentation		**10**	
Viva Voce		**10**	
TOTAL	**25**	**25**	**50**

SCHEME OF EVALUATION (SEE)		
Sl. No.	**Particulars**	**Max. Marks**
1	Relevance of the subject in the present context	**05**
2	Literature Survey	**05**
3	Problem formulation	**05**
4	Experimental observation / theoretical modelling	**05**
5	Results – Presentation & Discussion	**05**
6	Conclusions and scope for future work	**05**
7	Overall presentation	**20**
	Total Marks	**50**

ADMISSION YEAR: 2018-19 **ACADEMIC YEAR: 2021-22**
SEMESTER : EIGHTH

COURSE TITLE : INDUSTRY INTERNSHIP		
Sub Code: 18MEI83	**No of Credits : 02**	**No. of contact hours/week : 02**
Exam Duration : 3 hours	**CIE Marks: 50**	**SEE Marks : 50**

Internship: All the students admitted to III year of BE/B. Tech have to undergo mandatory internship of 4 weeks during the vacations of VI and VII semesters and /or VII and VIII semesters. If not completed after VI semester examinations, it has to be carried out during the intervening vacations of VII and VIII semesters). A University examination will be conducted during VIII semester and prescribed credit are added to VIII semester. Internship is considered as a head of passing and is considered for the award of degree. Those, who do not take-up/complete the internship will be declared as failed and have to complete during subsequent University examination after satisfy the internship requirements.

OBJECTIVE:

1. To inculcate the working procedure in the students in the industry by incorporating their knowledge gained during engineering course.
2. Exposing the student community to the real working environment in the industry.

PROCEDURE FOR INTERNSHIP:

1. Students shall approach any one of small, medium or large scale industries of their choice and get permission for carryout internship for a minimum duration of four weeks.
2. Obtain a permission/recommendation letter from the college to the respective industry to permit him/her to carry out the internship.
3. After obtaining a permission from industry, fix the time period for internship (during their intervening vacations of VII and VIII semester) after mutual discussion with the industry and the students. The same should be communicated to the department regarding the time period of internship.
4. Student should start and continue his/her internship with the assistance and guidance of the allotted authorised person to gain maximum knowledge of real time working in the industry.
5. Student should maintain a fact sheet of working (containing timings, machines, operations, softwares, programmes etc.) on day to day basis for his/her entire period of internship.
6. Obtain a signature in all the fact sheet from the authorised person under whom guidance he/she is working.
7. An internship certificate issued by that industry should be obtained and submitted to the department.
8. Immediately after completion of the internship he/she must prepare an internship report containing internship certificate and submit the report to the department for evaluation.

SCHEME OF EVALUATION (CIE): Internal evaluation will be conducted at the end of the semester by two internal faculty members nominated by the department.

SCHEME OF EVALUATION (CIE)		
DETAILS	**MAXIMUM MARKS**	**Two Internals faculty members**
Internship/ report	**30**	
Presentation	**10**	
Viva Voce	**10**	
Max Marks	**50**	

SCHEME OF EVALUATION (SEE): The viva-voce examination will be conducted by the two examiner's consisting of one internal examiner and another external examiner from industry where student undergone internship. In case, an external examiner is not available, a senior faculty member from the department can be used.

SCHEME OF EVALUATION (SEE)		
DETAILS	**MAXIMUM MARKS**	**Two examiners**
Presentation	**30**	
Viva Voce	**20**	
Max Marks	**50**	