ENGINEERING MATHEMATICS-III

(Common to all branches)

[As per Choice Based Credit System (CBCS) scheme]

(Effective from the academic year 2019-20)

Course Code : 18MAT31 | **CIE Marks : 50**

Contact Hours/Week : 04 | **SEE Marks: 50**

Total Hours:50 | **Exam Hours:03**

Semester : III | **Credits: 04**

Course Learning Objectives:

This course will enable students to:

- Introduce most commonly used analytical and numerical methods in the different engineering fields.
- Learn Laplace transform and Z-transforms, statistical methods, numerical methods.
- Solve the problem on Interpolation.
- To discuss the random variable and associated probability distributions.

MODULE-I

LAPLACE TRANSFORMS : Definition, Laplace transforms of Elementary functions, properties(without proof) periodic function, Unit step function, Unit impulse function.

INVERSE LAPLACE TRANSFORMS : Definition, Convolution Theorem(without proof), Finding Inverse Laplace transform by convolution Theorem. Solution of Linear Differential equations using Laplace Transforms and Applications(5 Assignment Problem).

10 - Hours

MODULE-II

Z- **TRANSFORMS:** Difference Equations ,Basic definitions, Damping rule, Shifting rule, Initial and Final Value theorems(without proof) and problems.

Inverse Z-transforms. Applications of Z-transforms to solve difference equation(5 Assignment Problem).

10 - Hours

MODULE-III

STATISTICAL METHODS: Correlation-karl Pearson's co-efficient of correlation problems. Regression analysis lines of regression (without proof)-problems.

CURVE FITTING: Curve fitting by the method of least square. Fitting of the curves of the form $y = ax + b, y = ax^2 + bx + c$ & $y = ae^{bx}$.

Numerical Methods: Numerical solution of algebraic and transcendental equations by Regula - Falsi Method and Newton-Raphson method. (5 Assignment Problem).

10 - Hours

MODULE-IV

FINITE DIFFERENCE: Forward and Backward differences, Newton's forward and backward interpolation formulae. Divided difference-Newton's divided difference formulae. Lagrange's-interpolation formula and inverse interpolation formula(all formula without proof) problems.

NUMERICAL INTEGRATION: Simpsons$(\frac{1}{3})^{rd}$, $(\frac{3}{8})^{th}$ rules, Weddle's rule (without proof) problems. (5 Assignment Problem).

10 - Hours

MODULE-V

Probability Distribution: Random variables(discrete and continuous) probability mass/density functions. Binomial distribution, Poisson distribution. Exponential and Normal distributions. Problems. (5 Assignment Problem).

10 - Hours

Course outcomes: On completion of this course, students are able to:

- Know the use of Laplace transform and inverse Laplace transform in signal and image processing.
- Explain the general linear system theory for continuous time signals and digital signal processing using Z-transform.
- Employ appropriate numerical methods to solve algebraic and transcendental equations .
- Apply Green's Theorem, Divergence Theorem and Stokes' theorem in various applica tion in the field of electro-magnetic and gravitational fields and fluid flow problems.

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, 43rd Ed., 2015.
2. E. Kreyszig: Advanced Engineering Mathematics, John Wiley & Sons,10th Ed., 2015.

Reference Books:

1. *N.P.Bali and Manish Goyal: A Text Book of Engineering Mathematics, Laxmi Publishers , 7th Ed., 2010.*
2. *B.V.Ramana: "Higher Engineering Mathematics" Tata McGraw-Hill, 2006.*
3. *H. K. Dass and Er. Rajnish Verma: "Higher Engineering Mathematics", S. Chand publishing, 1st edition, 2011.*

Web Link and Video Lectures:

1. *http://nptel.ac.in/courses.php?disciplineID=111*
2. *http://www.khanacademy.org/*
3. http://www.class-central.com/subject/math

BASIC THERMODYNAMICS

Semester: III

Course	Code	Credits	Total Hours - 50 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Tutorial	SEE	CIE	
Basic Thermodynamics	18ME32	04	03	01	50	50	03

COURSE OBJECTIVES

1. Learn about thermodynamic systems and boundaries
2. Study the basic laws of thermodynamics including, conservation of mass, conservation of energy or first law, second law and Zeroth law.
3. Understand various forms of energy including heat transfer and work.
4. Analyze displacement work for a part of system boundary & whole system
5. Identify various types of properties (e.g., extensive and intensive properties)
6. Use tables, equations, and charts, in evaluation of thermodynamic properties
7. Apply conservation of mass, first law, and second law in thermodynamic analysis of systems (e.g., turbines, pumps, compressors, heat exchangers, etc.)
8. Enhance their problem solving skills in thermal engineering

Module-1 Fundamental Concepts , Definitions , Work and Heat (10 hours)

Thermodynamic definition and scope, Microscopic and Macroscopic approaches. Some practical applications of engineering thermodynamic Systems. Thermodynamic systems and control volume with examples. Thermodynamic properties, states, processes and cycles, reversible and irreversible process, quasi-static process. Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium, Zeroth law of thermodynamics, Temperature; concepts, scales, international fixed points and measurement of temperature, simple problems on temperature concept.

Mechanics, definition of work and its limitations. Thermodynamic definition of work; examples, sign convention, Point and path function. Displacement work in quasi static process, other modes of work, Heat Transfer and Compression of heat and work.

Module-2 First Law of Thermodynamics (10 hours)

Joules experiments, equivalence of heat and work, Statement of the First law of thermodynamics, energy as a property, modes of energy, Different forms of stored energy, Corrollaries of first law, Specific heat at constant volume and constant pressure, application of first law to a closed system (Non Cyclic Processes), Steady and Unsteady flow process, Steady Flow Energy Equation (SFEE), Application of steady flow energy equation - work absorbing system, work developing system and non work absorbing and non work developing systems, related numerical problems.

Module-3 2nd law of Thermodynamic (10 hours)

Introduction and limitation of First law, Heat engine, Heat pump and Reversed Heat Engine, Energy Reservoirs kelvin – plank statement of second law, Clausius statement of second law, Equivalence of the two statements, Perpetual motion machine of second kind, Reversibility and Irreversibility Processes, Carnot cycle, Numerical Problems.

Module-4 Entropy (10 hours)

Entropy and its Definition, two reversible adiabatic lines cannot intersect each other, Clausius theorm and Clausius inequality, Entropy is a point function, T- S Diagram, principle of increase in entropy, Application of Entropy Principal, Entropy using Tds relation, Entropy Change for Ideal gas and numerical problems.

Module-5 pure substance , available and irreversibility, Ideal gases and real gases (10 hours)

Introduction, P-T-V of a pure substance, P-T Diagram, triple point and critical points, Enthalpy of steam, Latent heat, External work done, Internal energy of a system, state changes of system involving a pure system, dryness fraction, saturated vapors, two phase mixture, vapour phase, steam table, formation of steam at constant pressure, Measurement of dryness fraction of steam, Throttling calorimeter, separating and throttling calorimeter and numerical problems.

Definition, Daltons law of partial pressures, Amagat's law of additive volumes, Internal energy and specific heats of an ideal gas mixture, enthalpy of ideal gas mixture, entropy of ideal gas mixture, Van-der Waal's Equation of state, Van-der Waal\'s constants in terms of critical properties, Beattie-Bridgeman equation, compressibility factor; compressibility chart. Difference between Ideal and real gases.

COURSE OUTCOMES: The student will be able to

	Course Outcomes	**Course Level**
CO1	Explain thermodynamic systems, properties, Zeroth law of thermodynamics, temperature scales and energy interactions.	U
CO2	Determine heat, work, internal energy, enthalpy for flow &non flow process using First Law of Thermodynamics.	Ap
CO3	Determine heat, work, internal energy, enthalpy for flow &non flow process using Second Law of Thermodynamics.	U
CO4	Determine change in internal energy, change in enthalpy and change in entropy using TD relations for ideal gases.	Ap
CO5	Interpret behavior of pure substances and its applications to practical problems. Calculate Thermodynamics properties of real gases at all ranges of pressure, temperatures using modified equation of state including Vander Waals equation and Beattie Bridgeman equation.	Ap
	Total Number Lecture hours	**50**

TEXT BOOKS:

1. Basic Engineering Thermodynamics, A.Venkatesh, Universities Press, 2008
2. Basic thermodynamic, R K Hegde, Sapna publication.
3. Basic and Applied Thermodynamics, P.K.Nag, 2nd Ed., Tata McGraw Hill Pub. 2002

REFERENCE BOOKS:

1. Thermal Engineering, Dr C P Kothandaraman, Dhanpat rai & CO (P) LTD, Eductional & Techinical Publishers
2. Thermal Engineering, R K Rajput, Laxmi Publication LTD
3. Thermodynamics, An Engineering Approach, YunusA.Cenegal and Michael A.Boles, Tata McGraw Hill publications, 2002
4. Engineering Thermodynamics, J.B.Jones and G.A.Hawkins, John Wiley and Sons.
5. An Introduction to Thermodynamcis, Y.V.C.Rao, Wiley Eastern, 1993,
6. B.K Venkanna, Swati B. Wadavadagi "Basic Thermodynamics, PHI, New Delhi, 2010

DATA HANDBOOKS:

1. D1. Thermodynamic data hand book, B.T. Nijaguna.
2. D2. Properties of Refrigerant & Psychometric (tables & Charts in SI Units), Dr. S.S. Banwait, Dr. S.C. Laroiya, Birla Pub. Pvt. Ltd., Delhi, 2008.
3. D3. Thermodynamic data hand book R K Hegde.
4. D4. Thermodynamic data hand book R S Khrumi.

SCHEME OF EXAMINATION:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

MANUFACTURING PROCESS

Semester: III

Course	Code	Credits	Total Hours - 40 Hours /Week		Assessment		Exam Duration in Hrs
			Lecture	Tutorial	SEE	CIE	
Manufacturing Process	18ME33	03	03	00	50	50	03

COURSE OBJECTIVES

1. To provide detailed information about the molding processes and knowledge of various casting process in manufacturing.
2. To impart knowledge of various joining process used in manufacturing and build adequate knowledge of quality test methods conducted on welded and casted components.

Module-1 Introduction& basic materials used in foundry (10 hours)

Introduction: Definition, Classification of manufacturing processes. Metals cast in the foundry-classification, factors that determine the selection of a casting alloy. Introduction to casting process & steps involved. Patterns: Definition, classification, materials used for pattern, various pattern allowances and their importance.

Sand molding: Types of base sand, requirement of base sand. Binder, Additives definition, need and types.

Preparation of sand molds: Molding machines- Jolt type, squeeze type and Sand slinger. Study of important molding process: Green sand, core sand, dry sand, sweep mold, CO2 mold, shell mold, investment mold, plaster mold, cement bonded mold. Cores: Definition, need, types. Method of making cores, concept of gating (top, bottom, parting line, horn gate) and rise ring (open, blind) Functions and types.

Module-2 MELTING & METAL MOLD CASTING METHODS (10 hours)

Melting furnaces: Classification of furnaces, Gas fired pit furnace, Resistance furnace, Coreless induction furnace, electric arc furnace, constructional features & working principle of cupola furnace.

Casting using metal molds: Gravity die casting, pressure die casting, centrifugal casting, squeeze casting, slush casting, thixocasting, and continuous casting processes.

MODULE – 3 SOLIDIFICATIONS & NON-FERROUS FOUNDRY PRACTICE (10 hours)

Solidification: Definition, Nucleation, solidification variables, Directional solidification-need and methods. Degasification in liquid metals-Sources of gas, degasification methods.

Fettling and cleaning of castings: Basic steps involved. Sand Casting defects- causes, features and remedies. Advantages & limitations of casting process

Nonferrous foundry practice: Aluminum castings - Advantages, limitations, melting of aluminum using lift-out type crucible furnace. Hardeners used, drossing, gas absorption, fluxing and flushing, grain refining, pouring temperature. Stir casting set up, procedure, uses, advantages and limitations.

Module – 4 WELDING PROCESS (10 Hours)

Welding process: 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) Submerged Arc Welding (SAW) and Atomic Hydrogen Welding (AHW).

Special type of welding: Resistance welding principles, Seam welding, Butt welding, Spot welding and Projection welding. Friction welding, Explosive welding, Thermit welding, Laser welding and electron beam welding.

Module – 5 SOLDERING, BRAZING AND METALLURGICAL ASPECTS IN WELDING (10 Hours)

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, Shrinkage in welds& Residual stresses, Concept of electrodes, filler rod and fluxes. Welding defects- Detection, causes & remedy.

Soldering, brazing, gas welding: Soldering, Brazing, Gas Welding: Principle, oxy-Acetylene

welding, oxy-hydrogen welding, air-acetylene welding, Gas cutting, powder cutting.

Inspection methods: Methods used for inspection of casting and welding. Visual, magnetic particle, fluorescent particle, ultrasonic. Radiography, eddy current, holography methods of inspection.

COURSE OUTCOMES:

The student will be able to

	Course Outcomes	Course Level
CO1	Describe the casting process, preparation of Green, Core, dry sand molds and Sweep, Shell, Investment and plaster molds. Explain the Pattern, Core, Gating, Riser system and Jolt, Squeeze, Sand Slinger Molding Machines	U
CO2	Describing melting furnace, Gas fired pit furnace, Resistance furnace, Coreless induction furnace, electric arc furnace, constructional features & working principle of cupola furnace. Explaining metal mold casting process Gravity die casting, pressure die casting, centrifugal casting, squeeze casting, slush casting, thixocasting, and continuous casting processes.	Ap
CO3	Describing solidification of castings and finishing process of casted parts	Ap
CO4	Describe the Metal Arc, TIG, MIG, Submerged and Atomic Hydrogen Welding processes used in manufacturing. Explain the Resistance spot, Seam, Butt, Projection, Friction, Explosive, Thermit, Laser and Electron Beam Special type of welding process used in manufacturing.	Ap
CO5	To develop the knowledge of different metal joining processes and to study about the inspection of joints.	Ap
	Total Number Lecture hours	**50**

TEXT BOOKS:

1. "Manufacturing Process-I", Dr.K.Radhakrishna, Sapna Book House,5th Revised Edition 2009.
2. "Manufacturing & Technology: Foundry Forming and Welding",P.N.Rao, 3rd Ed., Tata McGraw
3. Machine tools & operations, AnupGoel, Technical publications,2nd edition 2018.
4. Machine tools and operations, Sagar M. Baligidad, Sunsatar publishers,1st edition 2017.
5. Metal cutting and machine tool engineering, Pakirappa, Durga publishing house, 3rd edition 2015-16.
6. Manufacturing process-2, Kestoor Praveen, Suggi publishing,5th edition 2013.

REFERENCE BOOKS:

1. "Process and Materials of Manufacturing", Roy A Lindberg, 4th Ed.PearsonEdu. 2006.

2. “Manufacturing Technology”, SeropeKalpakjian, Steuen. R. Sechmid,Pearson Education Asia, 5th Ed. 2006.
3. “Principles of metal casting”, Rechard W. Heine, Carl R. LoperJr., Philip C. Rosenthal, Tata McGraw Hill Education Private Limited Ed.1976
4. Fundamental of Machining and Machine Tools, Geoffrey Boothroyd and Winston A. Knight, CRC Taylor& Francis, Third Edition.
5. All about Machine Tools, Heinrich Gerling, New Age International Publishers revised 2nd Edition, 2006
6. Metal cutting principles, Milton C. Shaw, Oxford University Press, Second Edition,2005.

SCHEME OF EXAMINATION:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

MATERIAL SCIENCE

Semester: III

Course	Code	Credits	Total Hours - 40 Hours /Week		Assessment		Exam Duration in Hrs
			Lecture	Tutorial	SEE	CIE	
Material Science	18ME34	03	03	00	50	50	03

Course objectives:

1. Exemplify different engineering materials and their metallurgical properties.
2. Interpret different alloy phase diagrams, particularly Iron-Iron Carbide phase diagram.
3. Distinguish different ferrous and non-ferrous metals based on their microstructure.
4. Summarize different properties and applications of ceramics, polymers, composites and advanced materials.

Module 1: Basics, Mechanical Behavior, Failure of Materials

Structure of Metals: Simple Cubic, BCC, FCC and HCP Structures, Coordination number, atomic Packing Efficiency, Crystal imperfections – point, line, surface and volume imperfections, Atomic Diffusion: Phenomenon, Fick's laws of diffusion; Factors affecting diffusion.

Mechanical Behavior: Concepts of stress and strain: tension test, compression tests, shear and torsion tests, elastic deformation stress–strain behavior, elasticity, elastic properties of materials, plastic deformation: tensile properties, ultimate tensile strength, ductility, resilience, toughness, true stress and strain, and elastic recovery after plastic deformation.

Module 2: Fracture, Fatigue, Creep and Mechanisms of strengthening in metals

Fracture: Fundamentals of fracture, ductile fracture, brittle fracture, ductile-to-brittle transition

Fatigue: Types of fatigue loading with examples, Mechanism of fatigue, Fatigue properties, S-N diagram, Fatigue testing

Creep: Description of the phenomenon with examples, three stages of creep, creep properties, Stress relaxation. Concept of fracture toughness.

Mechanisms of strengthening in metals: Strengthening by grain size reduction, solid-solution strengthening, strain hardening, Recovery, re-crystallization, and grain growth.

Module 3: Alloys, Phase diagrams and Iron-carbon diagram

Alloys: Concept of formation of alloys, Types of alloys, solid solutions, factors affecting solid solubility (Hume Rothery rules), Binary phase diagrams: Eutectic, and Eutectoid systems, Lever rule.

Phase Diagrams: Definitions and basic concepts: solubility limit, phases, microstructure, phase equilibria, one-component (or unary) Phase diagrams.

Iron carbon system - The iron–iron carbide ($Fe–Fe_3C$) phase diagram, development of microstructure in iron–carbon alloys, hypoeutectoid alloys, hypereutectoid alloys, nonequilibrium cooling, the influence of other alloying elements.

Module 4: Heat treatment, Ferrous and Non-ferrous materials
Heat treatment of metals: Heat treating of metals: Time-Temperature-Transformation (TTT) curves, Continuous Cooling Transformation (CCT) curves, Annealing: Recovery, Recrystallization and Grain growth, Types of annealing, Normalizing, Hardening, Tempering, Martempering, ustempering, Concept of hardenability, Factors affecting it hardenability, surface hardening methods: carburizing, cyaniding, nitriding, flame hardening and induction hardening, Age hardening of luminum-copper alloys and PH steels. **Ferrous materials:** Properties, Compositions and uses of Grey cast iron, white cast iron, Malleable iron, SG iron and steel. **Non-ferrous Metals and Alloys**: Structure and properties of copper and its alloys, Aluminum and its alloys, Al-Cu phase diagram, Titanium and its alloys.
Module 5: Advanced Materials
Composite materials: Composite materials - Definition, classification, types of matrix materials & reinforcements, Metal Matrix Composites (MMCs), Ceramic Matrix Composites (CMCs) and Polymer Matrix Composites (PMCs), Particulate-reinforced and fiber-reinforced composites, Fundamentals of production of composites, Processes for production of composites. **Other materials:** Smart materials, shape Memory alloys and nano material properties and applications.
Course outcomes: Describe the mechanical properties of metals, their alloys and various modes of failure. Understand the microstructures of ferrous and non-ferrous materials to mechanical properties. Explain the processes of heat treatment of various alloys. Understand the properties and potentialities of various materials available and material selection procedures. Know about composite materials, smart materials, shape memory alloys and Nano materials and their processing as well as applications.

TEXT BOOKS:

1. Mechanical Metallurgy/G E Dieter/ Tata McGraw-Hill/1997.
2. Introduction to Physical Metallurgy / Sidney H. Avener/3rd Edition / Tata McGraw – ill/2012.

REFERENCE BOOKS:

1. Material Science and Metallurgy for Engineers/ Kodgire V. D / Everest Publishing House/2011.
2. Science of Engineering Materials / B.K. Agarwal/ Tata McGraw –Hill/1988.
3. Materials Science and engineering / William and collister/8th Edition/ Wiley
4. Elements of Material science / V. Rahghavan/**5th** Edition Addison-Wesley Publishing Co.
5. An introduction to material science / W.G.Vinas & H.L. Mancini /Princeton
6. Material science & material / C.D. Yesudian & D.G.Hassis Samuel/ Scitech/2006.
7. Engineering Materials and Their Applications/R. A Flinn and P K Trojan / Jaico Books/1999.
8. Engineering materials and metallurgy/R.K.Rajput/1st Edition/ S. Chand/2006.
9. Essential of Materials science and engineering/ Donald R. Askeland and. Pradeep P Phule / Cengage Learning/2004.
10. Material Science/K. M. Gupta/Umesh Publications/2014.

COMPUTER AIDED MACHINE DRAWING

Semester: III

Course	Code	Credits	Total Hours - 40 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Practical	SEE	CIE	
CAMD	18MEL35	03	01	04	50	50	03

COURSE OBJECTIVES:

- To introduce students to the basics of standards of engineering drawing related to machine components.
- To enhance students technical skills regarding orthographic views conversion, part modeling and assembly.
- To impart student knowledge of threads forms, fasteners, riveted joints and shaft joints.
- To make student understand the use of limits, fits and tolerances pertaining to machine drawing in industries.
- To help students to gain knowledge about CAD software in drafting, modeling and assembly of machine components.

MODULE 01:

Sections of Solids: Sections of Pyramids, Prisms, Cubes, Cones and Cylinders resting only on their bases. (No problems on axis inclination, hollow solids and spheres). True shape of the sections.

4 hours.

Orthographic views: Conversion of pictorial views into orthographic projections of simple machine parts without section. 4 hours.

MODULE 02:

Thread forms: Thread terminology, sectional views of threads, ISO Metric (Internal & External), BSW, American Standard thread, Square and Acme thread, 4 hours

Fasteners: Hexagonal headed bolt and nut with washer (assembled view), square headed bolt and nut with washer (assembled view). 4 hours

MODULE 03:

Riveted joints: Single and double riveted lap joints, Butt joints with single/double cover straps (Chain and zigzag using snap head riveters).

5 hours

Shaft joints: Cotter joint (socket and spigot), Knuckle joint (pin joint) for two rods 5 hours

MODULE 04:

Limits, Fits and Tolerances: Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, Types of fits with symbols and applications, Geometrical tolerances on drawings, Standards followed in industry.

5 hours

Couplings: Split muff coupling, protected type flange coupling, Pin (bush) type flexible coupling, Oldham's coupling and Universal coupling (Hook's Joint).
5 hours

MODULE 05: Assembly Drawings: (Part drawings shall be given) 14 hours

1. Screw Jack (Bottle type)
2. Plummer block (Pedestal Bearing)
3. Machine vice
4. Lathe square tool post
5. Cross Head (IC engine).

COURSE OUTCOMES:

- Student will be able to acquire the knowledge of various standards and specifications about standard machine components.
- Students will be able to make assemblies with help of given part drawing.
- Student will acquire the knowledge of various standards and specifications about standard machine components.
- Student will be able to apply the knowledge of fits and tolerances in industrial applications
- Will get exposure to advanced CAD packages.

TEXT BOOKS:

1. 'Machine Drawing', N.D.Bhat & V.M.Panchal, Published by Charotar Publishing House, 1999.
2. 'Machine Drawing', N.Siddeshwar, P.Kannaih, V.V.S. Sastri, published by Tata Mc.Grawhill, 2006.

REFERENCE BOOKS

1. "A Text Book of Computer Aided Machine Drawing", S. Trymbakaa Murthy, CBS Publishers, New Delhi, 2007.
2. 'Machine Drawing', K.R. Gopala Krishna, Subhash publication.

SCHEME OF EVALUATION FOR CIE (50 MARKS)

(a) Class work (Sketching and Computer Aided Machine drawing printouts in A4 sheets): 35Marks.
(b) Internal Assessment test in the same pattern as that of the main examination: 15 marks.

SCHEME OF SEE EXAMINATION (50 MARKS)

Student has to solve three questions; pattern of questions are as follows

Question no	Modules	Marks
Q1	Module 01 OR Module 02	20
Q2	Module 03 OR Module 04	30
Q3	Module 5(Assembly) Or Module 5 (Assembly)	50
	Total	100

NOTE:

1. No restriction of timing for sketching/ computerization of solutions. The total duration is 3 hours.
2. It is desirable to do sketching of all the solutions before computerization.
3. Drawing instruments may be used for sketching.
4. For Q1, and Q2, 2D drafting environment should be used.
5. For assembly 3D part modeling and assembly should be used and extract 2D views.

MATERIAL SCIENCE LAB

Semester: III

Course	Code	Credits	Total Hours - 40		Assessment		Exam Duration in hrs
			Hours /Week				
			Tutorial	Practical	SEE	CIE	
Material Science Lab	18MEL36	01	00	02	50	50	03

Course Objectives:

1. To learn the concept of the preparation of samples to perform characterization such as microstructure, volume fraction of phases and grain size.
2. Calculate the various Mechanical properties of materials such as tensile, flexural, compression Strength and Hardness.
3. To learn material failure modes and the different loads causing failure.
4. To learn the concepts of improving the mechanical properties of materials by different methods like heat treatment, surface treatment etc.

PART-A

1. Preparation of specimen for Metallographic examination of different engineering materials.
To report microstructures of (a) plain carbon steel, (b) tool steel, (c) gray C.I, (d) SG iron, (e) Brass, (f) Bronze (g) composites.
2. Brinell hardness test on metals
3.Rockwell hardness test on metals
4. Vickers's Hardness test on metals

PART-B

1. Tensile, shear and compression tests of metallic and wooden material specimens using Universal Testing Machine.
2. Bending Test on wooden specimen.
3. Torsion Test on steel bar.
4. Izod and Charpy Tests on Mild steel specimen.
5. Fatigue Test (Demonstration only).

Course outcomes:

· Acquire experimentation skills in the field of material testing.
· Develop theoretical understanding of the mechanical properties of materials by performing experiments.
· Apply the knowledge to analyze a material failure and determine the failure inducing agent/s.
· Apply the knowledge of testing methods in related areas.
· Know how to improve structure/behavior of materials for various industrial applications.

Scheme of Examination:

ONE question from part -A: 30 Marks
ONE question from part -B: 50 Marks
Viva -Voice: 20 Marks
Total: 100 Marks

WORKSHOP PRACTICE LAB

Semester: III

Course	Code	Credits	Total Hours - 40		Assessment		Exam Duration in hrs
			Hours /Week				
			Lecture	Practical	SEE	CIE	
Workshop Practice Lab	18MEL37	01	00	02	50	50	03

Course objectives:

To impart knowledge and skill to use tools, machines, equipment, and measuring instruments. Also Educate students of Safe handling of machines and tools.

PART-A

1.Demonstration on use of Hand Tools: V-block, Marking Gauge, Files, Hack Saw, Drills, Taps. Minimum 3 models involving Dove tail joint, Triangular joint and semicircular joint.

2.Sheet Metal & Soldering Work: Development & Soldering of the models: Tray, Frustum of cone, Prism (Hexagon &Pentagon), Truncated Square Pyramid, Funnel. 10 Hour

PART-B

3.Welding: Study of electric arc welding tools & equipments, Models: Butt Joint, Lap Joint, T joint & L-joint. 10 Hour

4 Carpentry: study of carpentry tools, making of models. Pattern making. 10 Hour

5. Knowing Safety procedures and precautions in workshop. 2 Hour

Course outcomes:

At the end of the course, the student will be able to:

1. Demonstrate and produce different types of fitting models.
2. Gain knowledge of development of sheet metal models with an understanding of their applications.
3. Perform soldering and welding of different sheet metal & welded joints.
4. Understand the Basics of Workshop practices.

Text book:

1.Elements of Workshop Technology: Vol I: Manufacturing Processes, S K Hajra.Choudhury, A K. Hajra Choudhury,15th Edition Reprinted 2013, Media Promoters &Publishers Pvt Ltd., Mumbai.

Reference Book:

1.A Textbook of Workshop Technology: Manufacturing Processes by R S Khurmi, 16th edition, S. Chand Publishing.

2. Workshop Technology Part 1: volume 1 fifth edition, W. A. J. Chapman, Published January 1st 1972 by Elsevier Science.

3.Introduction to Basic Manufacturing Process & Workshop Technology Singh, Rajender, 2nd edition, new age international, Jan,2010.

Scheme of Examination:

ONE question from part -A: 30 Marks

ONE question from part -B: 50 Marks

Viva -Voice: 20 Marks

Total: 100 Marks

MINI PROJECT-III

Semester: III

Course	Code	Credits	Total Hours - 24		Assessment		Exam Duration in Hrs
			Hours /Week				
			Lecture	Practical	SEE	CIE	
Mini project-III	18MEMP38	01	00	02	50	50	02

OBJECTIVES:

To introduce fundamental concepts and analysis techniques in engineering to students across all disciplines.

Mini-project work:

Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.

YOGA

Semester: III

Course	Code	Credits	Total Hours - 40		Assessment		Exam Duration in Hrs
			Hours /Week				
			Lecture	Tutorial	SEE	CIE	
Yoga	HSMC	01	01	00	50	50	03

Module 1: Introduction to yoga, Warm-Up before yoga, Warm-up for Neck, Warm-up for Shoulders, Warm-up for Hands, Warm-up for Ankles.

Module 2: Standing Yoga Poses: Mountain (Tadasana), Vrksasana (Tree Pose), Natarajasana (Dancer Pose), Chair Pose *(Utkatasana),* Half Wheel Pose (Ardha Chakrasana), Standing Forward Bend Pose (Uttanasana)

Module 3: Sitting Yoga poses: Padmasana (Lotus Pose), Bound Angle Pose (Baddha Konasana), Forward Fold (Paschimottanasana), Boat Pose (Navasana), Head-to-Knee Forward Fold (Janu-Sirsasana), Hero Pose (Virasana), Vajrasana(Thunderbolt), Ustrasana (Camel pose), Asanas on back,Shavasana (Corps pose), Supta Pavan Muktasan, Tanasan, Uttan apadasan, Setu bandasan, Sarvangasana, Halasan, Chakrasana.

Module 4: Asanas Lying on stomach: Shithilasan, Nabhi asana, Bhujangasana , Makrasana, Shalabhasana, Dhanurasna.

Module 5: Surya namaskara (Sun Salutation) Pranayam: Kapalabhati, Anulom Vilom Pranayama, Bhramari Pranayama, Mediatatio

ENGINEERING MATHEMATICS-IV

(Common to all branches)

[As per Choice Based Credit System (CBCS) scheme]

(Effective from the academic year 2018-19)

Course Code: 18MAT41 **CIE Marks: 50**
Contact Hours/Week: 04 **SEE Marks: 50**
Total Hours:50 **Exam Hours:03**
Semester: IV **Credits: 04**

Course Learning Objectives:

This course will enable students to:

- Learn Fourier series and Fourier transforms.
- Conversant with numerical methods to solve ordinary differential equations, complex analysis, joint probability distribution and stochastic processes arising in science and engineering.

MODULE-I

Fourier Series: Periodic functions, Dirichlet's condition, Fourier Series of periodicfunctio ns with period 2π and with arbitrary period 2c. Fourier series of even and odd fun ctions Half range Fourier Series, practical harmonic analysis(5 Assignment Problem).

10 - Hours

MODULE-II

Fourier Transforms: Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier-transform (5 Assignment Problem).

Complex line Integrals: Cauchy's Integration theorem, Cauchy integral formula, Laurent's Series, types of singularities. Residue, Poles, Cauchy's Residue theorem (without proof) and Problems.

Transformations: Bilinear transformations and problems.

10 - Hours

MODULE-III

Numerical Methods: Numerical solution of ordinary differential equations of first order andfirst degree, Taylor's series method, modified Euler's-method
Runge Kutta method of fourth order. Milne's and Adams- Bashforth predictor and corrector methods (No derivations of formulae). (5 Assignment Problem).

10 - Hours

MODULE-IV

Numerical Methods: Numerical solution of second order ordinary differential equations, Runge- Kutta Method and Milne's Method, Numerical solution of P.D.E: Numerical solution of Heat equation, Wave equation, problems. (5 Assignment Problem).

10 - Hours

MODULE-V

Joint probability distribution: Joint Probability distribution for two discrete random variables, expectation, covariance, correlation coefficient.

Stochastic process: Stochastic processes, probability vector, stochastic matrices, fixed p

oints, regular stochastic matrices, Markov chains, higher transition probability-simple problems.
(5 Assignment Problem).

10 - Hours

Course Outcomes: On completion of this course, students are able to:

- Know the use of periodic signals and Fourier series to analyze circuits and system communications.
- Explain the general linear system theory for continuous time signals and digital signal processing using the Fourier Transform.
- Solve first and second order ordinary differential equations arising in flow problems using single step and multistep numerical methods.
- Understand the analyticity, potential fields, residues and poles of complex potentials in field theory and electromagnetic theory.
- Describe bilinear transformation arising in aerofoil theory, fluid flow visualization and image processing.
- Solve problems on probability distributions relating to digital signal processing, information theory and optimization concepts of stability of design and structural engineering.
- Determine joint probability distributions and stochastic matrix connected with the multivariable correlation problems for feasible random events.
- Define transition probability matrix of a Markov chain and solve problems related to discrete parameter random process.

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, 43rd Ed., 2015.
2. E. Kreyszig: Advanced Engineering Mathematics, John Wiley & Sons,10th Ed., 2015.

Reference Books:

1. *N.P.Bali and Manish Goyal: A Text Book of Engineering Mathematics, Laxmi Publishers , 7th Ed., 2010.*
2. *B.V.Ramana: "Higher Engineering Mathematics" Tata McGraw-Hill, 2006.*
3. *H. K. Dass and Er. Rajnish Verma: "Higher Engineering Mathematics", S. Chand publishing, 1st edition, 2011.*

Web Link and Video Lectures:

1. *http://nptel.ac.in/courses.php?disciplineID=111*
2. *http://www.khanacademy.org/*
3. *http://www.class-central.com/subject/math*

FLUID MECHANICS

Semester: IV

Course	Code	Credits	Total Hours - 40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Fluid Mechanics	**18ME42**	**03**	**03**	**00**	**50**	**50**	**03**

Course Objectives:

- To understand the basic principles and fundamental concepts of fluid mechanics.
- To make the students to understand the concept and apply the various laws solving the fluid engineering problems.
- To make the students familiar with measurements and visualisation of fluid flow types, kinematics, dynamics and its analysis.
- To understand the concept flow of liquids through pipes and different sections and the dimensional quantities.

Course outcomes:

	Course Outcomes	Course Level
C01	To analyses a variety of practical fluid flow and measuring devices and utilize fluid mechanics principles in design.	U
C02	To understand fluid properties and their significance, concept of fluid pressure and related measurement devices	Ap
C03	To visualize different types of fluid flow, and compare them based on kinematic flow descriptions.	U
C04	To understand how mass and momentum is conserved based on Bernoulli's & Newton's laws and its applications.	Ap
C05	To understand the concept of laminar and turbulent flows, flow through pipe loses and dimensional quantities.	Ap
	Total number of lecture hours	50

Module-1 10 hours

Basics concepts and definitions: Introduction, Properties of fluids-mass density, weight density, specific volume, specific gravity, viscosity, surface tension, capillarity, vapour pressure, compressibility and bulk modulus.
Concept of continuum, types of fluids, pressure at a point in the static mass of fluid, variation of pressure, Pascal's law, absolute, gauge, atmospheric and vacuum pressures. Pressure measurement by simple, differential manometers, mechanical gauges and numerical.

Module-2 10 hours

Fluid Statics: Hydrostatic forces on submerged horizontal plane, vertical plane and inclined planeto determine total pressure and center of pressure in static fluid.Buoyancy, center of buoyancy, Meta center and Meta centric heights application in shipping, stability of floating bodies.

Module-3 10 hours

Fluid Kinematics: Types of flows -steady, unsteady, uniform, non-uniform, laminar, turbulent,one,two and three dimensional, compressible, incompressible, rotational, irrational, stream lines, path lines, streak lines, velocity components, convective and local acceleration, velocity potential, stream function, continuity equation in Cartesian co-ordinates.
Types of Motion, Vorticity and Rationality; Comparison of two circular flows, rotation, vorticity and circulation, Laplace equation in velocity potential and Poisson equation in stream function, flow net and numerical.

Module-4 10 hours

Fluid Dynamics: Introduction to conservation of mass equation of motion, Euler's equation of motion, Bernoulli's equation, Bernoulli's theorem, Application of Bernoulli's theorem on venture meter, orifice meter, rectangular and triangular notch, pitot tube, orifices and limitations and numerical.
Momentum equation for flow systems: Newton's laws and conservation of momentum; choosing a control volume; forces acting on a control volume; the linear momentum equation and its application on force on pipe bend and numerical.

Module-5 10 hours

Flow through pipes: Minor losses through pipes. Darcy's and Chezy's equation for loss of head due to friction in pipes. Hydraulic Gradient Line and Total Energy Line.
Laminar flow and viscous effects: Reynolds number, critical Reynolds number, laminar flow through circular pipe-Hagen Poiseille's equation, laminar flow between parallel and stationary plates.
Dimensional Analysis: Introduction, dimensions of physical quantities, dimensional homogeneity, Buckingham Pi-theorem, dimensionless numbers, similitudes, Reynolds model law, Mach model law.

Text books:

1. Fluid Mechanics (SI Units), Yunus A. Cengel John M.Oimbala, 2nd Ed., Tata McGraw Hill.
2. Fluid Mechanics, Dr.Bansal, R.K.Lakshmi Publications, 2004.
3. Streeter V L, Benjamin Wylie E, Bedford K W Fluid Mechanics, WCB/Mcgraw Hill 1998.

Reference Books:

1. Fluid Mechanics, Oijush.K.Kundu, IRAM COCHEN, ELSEVIER, 3rd Ed. 2005.
2. Fluid Mechanics and hydraulics, Dr.Jagadishlal: Metropolitan Book Co-Ltd., 1997.
3. Fluid Mechanics, John F. Douglas, Janul and M.Gasiosek and john A.Swaffield, Pearson Education Asia, 5th ed., 2006.
4. Fluid Mechanics and Fluid Power Engineering, Kumar.D.S, Kataria and Sons, 2004
5. Fluid Mechanics -. Merle C. Potter, Elaine P.Scott. Cengage learning.

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions choosing at least one full question from each module.

MECHANICS OF MATERIALS

SEMESTER: IV

COURSE OBJECTIVES:

Course	Code	Credits	Total Hours-50		Assessment		Exam Duration in Hrs
			Hours/Week				
Mechanics of Materials	18ME43	04	Lecture	Tutorial	SEE	CIE	
			03	01	50	50	03

1. To study different types of stresses, strain and deformation induced in the mechanical components due to external loads.
2. To study the behaviour of beams under transverse loading.
3. To study behaviour of structural members in Torsion.
4. To understand stability of columns.
5. To predict the stress distribution in pressure vessels.

MODULE: I **12 Hours**

Simple Stress and Strain: Introduction, Properties of Materials, stress, strain, Hook's law, Poisson's Ratio, Stress-Strain diagrams, Principles of super position, total elongation of tapering bars of circular and rectangular cross sections. Stresses due to temperature change.

Volumetric strain: Expression for volumetric strain, elastic constants relationship among Elastic constants, thermal stresses including compound bars.

MODULE: II **10 Hours**

Principal stresses and strains: Principal planes, principal stresses and strains, biaxial state of stress combined with shear, concept of Mohr's circle diagram.

Theories of Failures: Maximum Principal stress theory, Maximum shear stress theory, Maximum strain theory, Maximum strain energy theory and Maximum Distortion energy theory.

MODULE: III **08 Hours**

Shear Forces and Bending Moments: Type of beams, Loads and reactions, Relationship between loads, shear force and bending moments. Shear force and bending moments of cantilever beams, Pin support and roller supported beams subjected to concentrated loads and uniformly distributed constant / varying loads.

MODULE: IV **10 Hours**

Stress in Beams: Pure bending, curvature of beam, Longitudinal strains in beams, Normal stresses in Beams with rectangular, circular, 'I' and 'T' cross sections, Flexure Formula, Bending Stresses.

Elastic stability of columns: Euler's theory for axially loaded elastic long columns. Rankine's formula. Derivation of Euler's load for various end conditions.

MODULE: V **10 Hours**

Torsion of shafts: Assumptions in theory of pure torsion, Torsion equations, Torsional rigidity and modulus of rupture, Power transmitted, Comparison of solid and hollow circular shafts. Numerical problems.

Thick and Thin cylinders: Stresses in thin cylinders, Changes in dimensions of cylinder (diameter, length and volume), Thick cylinders subjected to internal and external pressures (Lame's equation).

COURSE OUTCOMES:

	Course Outcomes	Course Level
C01	To demonstrate fundamental knowledge about various types of loading and stresses induced in elastic bodies.	U
C02	To determine plane stress, principal stress and maximum shear stress using Mohr's circle.	Ap
C03	To Draw the SFD and BMD for different types of loads and support conditions.	U
C04	To Analyse buckling and bending phenomenon in columns and beams.	Ap
C05	To give an ability to apply the knowledge of mechanics of materials on engineering applications and design problems.	Ap
	Total Number of Lecture hours	**50**

TEXT BOOKS:

1.Strength of Materials by S.S. Bhavikatti, Vikas Publications House Pvt. Ltd. New Delhi,2012
2.Strength of Materials by R K Bansal, Laxmi Publication Pvt Ltd.,2016
3.Strength of Materials by R Subramanian, Oxford university press, 2010.
4.Strength of Materials by S.Ramamrutham, Dhanapath Rai Publishing Company, New Delhi,2012

REFERENCE BOOKS:

1.Mechanics of Materials by James Gere, Thomson Publication, 2010.
2.Strength of Materials by S S Rattan, McGraw Hill, 2011.
3.Mechanics of materials by Ferdinand Beer and Russell Johston, Tata McGraw Hill, 2003.

SCHEME OF EXAMINATION:

- Two questions to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

INSTRUMENTATION AND METROLOGY

Semester: IV

Course	Code	Credits	Total Hours - 40 Hours /Week		Assessment		Exam Duration in Hrs
			Lecture	Tutorial	SEE	CIE	
Mechanical Measurements and Metrology	18ME44	03	03	00	50	50	03

COURSE OBJECTIVES

1. To provide knowledge on various Metrological equipments available to measure the dimension of the components.
2. To provide knowledge on the correct procedure to be adopted to measure the dimension of the components.

Module -1 Basics of Metrology (6 Hours)

Introduction to Metrology – Need – Elements – Work piece, Instruments – Persons – Environment – their effect on Precision and Accuracy – Errors – Errors in Measurements – Types – Control – Types of standards.

Module -2 Linear and Angular Measurements (10 Hours)

Linear Measuring Instruments – Evolution – Types – Classification – Limit gauges – gauge design – terminology – procedure – concepts of interchange ability and selective assembly – Angular measuring instruments – Types – Bevel protractor clinometers angle gauges, spirit levels sine bar – Angle alignment telescope – Autocollimator – Applications.

Module -3 Advances in Metrology (12 Hours)

Basic concept of lasers Advantages of lasers – laser Interferometers – types – DC and AC Lasers interferometer – Applications – Straightness – Alignment. Basic concept of CMM – Types of CMM – Constructional features – Probes – Accessories – Software – Applications – Basic concepts of Machine Vision System – Element – Applications.

Module -4 Form Measurement (12 Hours)

Principles and Methods of straightness – Flatness measurement – Thread measurement, gear measurement, surface finish measurement, Roundness measurement – Applications.

Module -5 Measurement of Power, Flow and Temperature (10 Hours)

Force, torque, power – mechanical, Pneumatic, Hydraulic and Electrical type. Flow measurement: Venturimeter, Orifice meter, rotameter, pitot tube – Temperature: bimetallic strip, thermocouples, electrical resistance thermometer – Reliability and Calibration – Readability and Reliability.

COURSE OUTCOMES:

The student will be able to

	Course Outcomes	Course Level
CO1	Describe the concepts of measurements to apply in various metrological instruments.	U
CO2	Outline the principles of linear and angular measurement tools used for industrial applications.	Ap
CO3	Explain the procedure for conducting computer aided inspection.	U
CO4	Demonstrate the techniques of form measurement used for industrial components.	Ap
CO5	Discuss various measuring techniques of mechanical properties industrial applications.	Ap
	Total Number Lecture hours	**50**

Text Books:

1. Jain R.K. “Engineering Metrology”, Khanna Publishers.
2. Gupta. I.C., “Engineering Metrology”, Dhanpatrai Publications, 2005.

Reference Books:

1. Charles Reginald Shotbolt, “Metrology for Engineers”, 5th edition, Cengage Learning EMEA,1990.
2. Backwith, Marangoni, Lienhard, “Mechanical Measurements”, Pearson Education , 2006.

SCHEME OF EXAMINATION:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

FLUID MECHANICS LAB

Semester: IV

Course	Code	Credits	Total Hours - 24 Hours /Week		Assessment		Exam Duration in Hrs
			Lecture	Practical	SEE	CIE	
fluid mechanics lab	18MEL45	01	00	02	50	50	03

OBJECTIVES:

Upon Completion of this subject, the students can able to have hands on experience in flow measurements using different devices and also perform calculation related to losses in pipesand also perform characteristic study of pumps, turbines etc.

LIST OF EXPERIMENTS:

PART-A

1) Study of taps, valves, pipe fittings, gauges, pitot tubes, water meters and current meters.
2) Calibration of Pressure gauges
3) Determination of metacentric height and radius of gyration of floating bodies.
4) Verification of Bernoulli's theorem
5) Reynolds experiment

PART-B

6) Hydraulic coefficients of orifices and mouth pieces under constant head method and time of emptying method.
7) Determination of the Coefficient of discharge of given Orifice meter.
8) Determination of the Coefficient of discharge of given Venturi meter.
9) Determination of the Coefficient of discharge of given V-Notch 60^0, 90^0 and rectangular notch
10) Determination of force due to impact of jets.
11) Determination of friction factor for a given set of pipes.
    a) Major loss.
    b) Minor loss.

OUTCOMES:

1) Ability to use the measurement equipments for flow measurement.
2) The students will be able to understand the different flow measurement equipment's and their procedures.
3) Able to develop the skill of experimentation techniques for the study of flow phenomena in channels/pipes.

Scheme of Examination:

ONE question from part -A: 30 Marks
ONE question from part -B: 50 Marks
Viva -Voice: 20 Marks
Total: 100 Marks

INSTRUMENTATION AND MEASUREMENT LAB

Semester: IV

Course	Code	Credits	Total Hours - 24 Hours /Week		Assessment		Exam Duration in Hrs
			Tutorial	Practical	SEE	CIE	
Instrumentation and Measurement Lab	18MEL46	01	00	02	50	50	03

COURSE OBJECTIVES

1. To illustrate the theoretical concepts taught in Mechanical Measurements & Metrology through experiments.
2. To illustrate the use of various measuring tools measuring techniques.
3. To understand calibration techniques of various measuring devices.

PART-A:

1. Calibration of Pressure Gauge
2. Calibration of Thermocouple
3. Calibration of LVDT
4. Calibration of Load cell
5. Determination of modulus of elasticity of a mild steel specimen using strain gauges.

PART-B:

1. Measurements using Optical Projector / Toolmaker Microscope.
2. Measurement of angle using Sine Center / Sine bar / bevel protractor
3. Measurement of alignment using Autocollimator / Roller set
4. Measurement of cutting tool forces using a) Lathe tool Dynamometer OR b) Drill tool Dynamometer.
5. Measurements of Screw thread Parameters using two wire or Three-wire methods.
6. Measurements of Surface roughness, Using Tally Surf/Mechanical Comparator
7. Measurement of gear tooth profile using gear tooth Vernier /Gear tooth micrometer
8. Calibration of Micrometer using slip gauges
9. Measurement using Optical Flats

COURSE OUTCOME

1. To calibrate pressure gauge, thermocouple, LVDT, load cell, micrometer
2. To measure angle using Sine Center/ Sine Bar/ Bevel Protractor, alignment using Autocollimator/ Roller set.
3. To demonstrate measurements using Optical Projector/Tool maker microscope, Optical flats.
4. To measure cutting tool forces using Lathe/Drill tool dynamometer.
5. To measure Screw thread parameters using 2-Wire or 3-Wire method, gear tooth profile using gear tooth vernier/Gear tooth micrometer.
6. To measure surface roughness using Tally Surf/ Mechanical Comparator.

Scheme of Examination:

ONE question from part -A:	30 Marks
ONE question from part -B:	50 Marks
Viva -Voice:	20 Marks
Marks Total:	100 Marks

FOUNDRY AND FORGING LAB

Semester: IV

Course	Code	Credits	Total Hours - 50 Hours /Week		Assessment		Exam Duration in Hrs
			Lecture	Practical	SEE	CIE	
Foundry and Forging lab	18MEL47	02	01	02	50	50	03

COURSE OBJECTIVES:

1. To provide an insight into different sand preparation and foundry equipment's.
2. To provide an insight into different forging tools and equipment's.
3. To provide training to students to enhance their practical skills.
4. To practically demonstrate precautions to be taken during casting and hot working.
5. To develop team qualities and ethical principles.

PART A

1. **Testing of Molding sand and Core sand**

Preparation of sand specimens and conduction of the following tests:

1. Compression, Shear and Tensile tests on Universal Sand Testing Machine.
2. Permeability test
3. Sieve Analysis to find Grain Fineness Number (GFN) of Base Sand
4. Clay content determination in Base Sand.

PART B

2. Foundry Practice

1. Use of foundry tools and other equipment's.
2. Preparation of molding sand mixture.
3. Preparation of green sand molds using two molding boxes kept ready for pouring.

• Using patterns (Single piece pattern and Split pattern)

• Without patterns.

• Preparation of one casting (Aluminum or cast iron-Demonstration only)

PART C

3. Forging Operations:

Use of forging tools and other equipment's

• Calculation of length of the raw material required to prepare the model considering scale loss.

• Preparing minimum three forged models involving upsetting, drawing and bending operations.

• Demonstration of forging model using Power Hammer.

COURSE OUTCOMES

Students will be able to

1. Demonstrate various skills of sand preparation, molding.
2. Demonstrate various skills of forging operations.
3. Work as a team keeping up ethical principles.

Question paper pattern:	
One question is to be set from Part-A	30 Marks
One question is to be set from part-B or part-C model	50 Marks
Viva – Voce	20 Marks

MINI PROJECT-IV

Semester: IV

Course	Code	Credits	Total Hours - 24		Assessment		Exam Duration in Hrs
			Hours /Week				
			Lecture	Practical	SEE	CIE	
Mini project-IV	18MEMP48	01	00	02	50	50	02

OBJECTIVES:

To introduce fundamental concepts and analysis techniques in engineering to students across all disciplines.

Mini-project work:

Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.

MANAGEMENT AND ENTREPRENEURSHIP DEVELOPMENT

Semester: V

Course	Code	Credits	Total Hours - 40 Hours /Week		Assessment		Exam Duration in Hrs
			Lecture	Tutorial	SEE	CIE	
Management and Entrepreneurship Development	18HSM51	03	03	00	50	50	03

Course Objectives: The course aims:

1. Explain fundamentals management functions of a manager. Also explain planning and decision-making processes.
2. Explain the organizational structure, staffing and leadership process.
3. Describe the understanding of motivation and different control systems in management.
4. Explain understanding of Entrepreneurships and Entrepreneurship development process.
5. Illustrate Small Scale Industries, various types of supporting agencies and financing available for an entrepreneur.
6. Summarize the preparation of project report, need significance of report.

MODULE 1 08 Hours

INTRODUCTION

Introduction - Meaning, nature and characteristics of management, scope and Functional areas of management, goals of management, levels of management, brief overview of evolution of management theories,. Planning- Nature, importance, types of plans, steps in planning, Organizing- nature and purpose, types of Organization, Staffing- meaning, process of recruitment and selection

MODULE 2 08 Hours

ENTREPRENEUR

Meaning of entrepreneur, characteristics of entrepreneurs, classification and types of entrepreneurs, various stages in entrepreneurial process, role of entrepreneurs in economic development, entrepreneurship in India and barriers to entrepreneurship. Identification of business opportunities, market feasibility study, technical feasibility study, financial feasibility study and social feasibility study.

MODULE 3 08 Hours

PROJECT AND ERP

Meaning of project, project identification, project selection, project report, need and significance of project report, contents, formulation, guidelines by planning commission for project report, ERP and Functional areas of Management – Marketing / Sales- Supply Chain Management – Finance and Accounting – Human Resources – Types of reports and methods of report generation

MODULE 4 08 Hours

SMALL AND MEDIUM ENTERPRISES

Meaning and definition (evolution) Role and importance, Policies governing SMEs Organizational structure Steps in setting up a small unit, SME funding. Requirements of capital (fixed and working), Factors determining capital requirements, Importance of fixed and working capital, Working capital management, Sources of finance for SME'S. Taxation benefits. SIDBI and SISI – Their role in the development of SMEs. Taxation benefits SIDBI and SISI – Their role in the development of SMEs. Marketing mechanism in SMEs Problems of SMEs and prospects Turnaround strategies for SMEs

MODULE 5 08 Hours

SOCIAL RESPONSIBILITY AND MANAGERIAL ETHICS

Social Responsibility, Social Responsibility and Economic Performance, The Greening of Management – Social Obligation, Social Responsiveness and Social Responsibility, Value Based Management, Managerial Ethics, Different NGOs, Social Responsibility and Ethics Issues in Today's World

COURSE OUTCOMES:

The student will be able to

	Course Outcomes	Course Level
CO1	Define management, organization, entrepreneur, planning, staffing, ERP and outline their importance in entrepreneurship	U
CO2	Utilize the resources available effectively through ERP	Ap
CO3	Explain the organizational structure, staffing and leadership processes	Ap
CO4	Illustrate Small Scale Industries, various types of supporting agencies and financing available for an entrepreneur	Ap
CO5	Understands the Social Responsibility and Economic Performance	U

TEXT BOOKS:

1. Small scale industries and entrepreneurship, Dr. Vasant Desai, Himalayan Publishing House
2. Principles of Management – P. C. Tripathi, P.N. Reddy – Tata McGraw Hill.
3. Dynamics of Entrepreneurial Development & Management-Vasant Desai,Himalaya PublishingHouse.
4. Entrepreneurship Development – Poornima. M. Charantimath, Small Business Enterprises – PearsonEducation - 2006 (2 & 4).

REFERENCE BOOKS:

1. Management Fundamentals - Concepts, Application, Skill Development – RobersLusier, Thomson.
2. Entrepreneurship Development - S. S. Khanka, S. Chand & Co. New Delhi.
3. Management - Stephen Robbins, Pearson

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

APPLIED THERMODYNAMICS

Semester: V

Course	Code	Credits	Total Hours-50 Hours /Week		Assessment		Exam Duration Hours
			Lecture	Tutorial	SEE	CIE	
Applied Thermodynamics	18ME52	04	03	01	50	50	03

COURSE OBJECTIVES:

1) To introduce student about application of thermodynamics using gas power cycles.
2) To study basic concepts of combustion of fuels, SI, CI engine and performance of engine.
3) To study the different types of cycle used in industrial application and also the concept of refrigeration and psychrometric chart.
4) To study application of steam turbine used in various thermodynamic application.
5) To study concepts and different types of steam turbines.
6) To study different types of compressors and their related efficiency.
7) To get use of standard refrigerant property data book, Steam Tables, Mollier diagram and Psychrometric chart.

MODULE: 1

Gas power cycle: Air Standard cycles and assumptions: Carnot, Otto, Diesel, Dual and Stirling cycles,P-V and T-S diagrams, description, efficiencies, related numerical problems. Mean effective pressures: Otto cycle, Diesel cycle, Dual cycle, Comparison of Otto, Diesel and Dual cycles, related numerical problems.

MODULE: 2

Fuels & Combustion of Fuels:

Introduction to fuels, types of fuel, calorific value of fuels, Bomb Calorimeter, combustion of fuels, Theoretical (Stoichiometric) amount of Oxygen / Air required for complete combustion of fuel, Air-Fuel ratio, Excess air, percentage of excess air, mass balance, conversion of volumetric analysis to mass analysis and vice-versa **(No Numerical Treatment on fuels and combustion, only basic definitions and terminologies to be covered)**

I.C. Engine:

Introduction, classification and application I C engine, combustion in S.I. engine, factor effecting ignition lag, flame propagation, detonation or knocking in S I engine, effects of

knocking, factor effecting knocking, rating of S I engine fuel, combustion in C.I. engine, delay period, knocking, rating of C I engine fuels.

Testing of two stroke and four stroke SI and CI engines for performance Related numerical problems (engine performance parameters), heat balance, Motoring Method, Willian's line method, Morse test, related numerical problems.

MODULE: 3

Vapor Power cycles: Rankine cycle, effect of pressure and temperature on Rankine cycle,

Reheat cycle, Regenerative cycle, Feed water heaters (open and closed), Combined cycles, numerical problems.

Refrigeration and Psychometry

Introduction, COP, unit of refrigeration and performance factor, refrigerator and heat pump, required properties of ideal refrigerant, important of refrigerants, Air refrigeration: Carnot cycle, bell-Coleman cycle. Introduction, psychrometry and psychrometric properties, psychometric relation, chart, and psychometric process**. (simple problems on refrigeration and psychrometry)**

MODULE: 4

Impulse Turbines: Principles of operation, Classification, Impulse and reaction steam turbine, compounding of steam turbines, Velocity diagrams, Work done, Efficiencies, End thrust, Blade friction, Influence of ratio of blade speed to steam speed on efficiency of single turbines and its condition curve and reheat factors. related numerical problems.

Reaction Turbines Flow through impulse reaction blades, Velocity diagram, and degree of reaction, Parson's reaction turbine, Performance of steam turbines, related numerical problems.

MODULE: 5

Compressors: Introduction, working of reciprocating air compressor, air compressor terminology, Application of SFEE, work done by compressor with and without clearance, isothermal efficiency, volumetric efficiency, multi stage compressor, condition for minimum work, numerical problems.

Rotary Air Compressors- Classification, Working and constructional centrifugal compressor and axial flow compressor.

COURSE OUTCOMES

At the end of this course, student will be able to

	COURSE OUTCOMES	COURSE LEVEL
CO1	To identify and formulate power production based on the fundamental's laws of thermal engineering.	**(L-1, L-2, L3)**
CO2	Understand and analyze the cycles of internal combustion engines in order to perform heat, work and efficiency calculations.	**(L-1, L-2, L3, L-4)**
CO3	Understand concept of Vapour power cycle and solve introductory problems on various cycle and also the concept of refrigeration and psychometric process.	**(L-1, L-2, L3, L-4)**
CO4	Understand, apply and analysis steam turbine velocity diagrams in order to determine stage calculations mathematically and graphically.	**(L-1, L-2, L3, L-4)**
CO5	Apply and analyze the single and multi-stage reciprocating air compressor cycles in order to carry out calculations on machine performance	**(L-1, L-2, L3, L-4)**
	Total Number Lecture Hours	**50**
	NOTE: All levels mentioned are as per Bloom's Taxonomy	

TEXT BOOKS:

1) Rajput. R. K., "Thermal Engineering" S.Chand Publishers, 2000
2) Kothandaraman.C.P, Domkundwar. S,Domkundwar. A.V., "A course in thermal Engineering",
   Fifth Edition," Dhanpat Rai & sons, 2002

REFERENCES:

1) Basic and Applied Thermodynamics by P.K. Nag, MCGRAW HILL INDIA
2) Applied thermodynamics by Onkar Singh, New Age International
3) Applied Thermodynamics for Engineering Technologists by Eastop, Pearson Education
4) Applied Thermodynamics by Venkanna And Swati, PHI
5) Theory of Stream Turbine by WJ Kearton
6) Gas turbine Theory & Practice, by Cohen & Rogers, Addison Weslay Long man
7) Gas Turbine, by V. Ganeshan, Tata McGraw Hill Publishers.
8) Steam & Gas Turbine by R. Yadav, CPH Allahabad

9) Thermodynamics and Energy Systems Analysis, Borel and Favrat, CRC Press
10) Thermodynamics by Prasanna Kumar, Pearson
11) Thermal Engineering by Kul Shrestha, Vikas Publishing.
12) Thermal Engg. By PL Ballaney, Khanna Publisher
13) Thermal Engg. By RK Rajput, Laxmi Publication
14) Sarkar, B.K,"Thermal Engineering" Tata McGraw-Hill Publishers, 2007
15) Arora," Refrigeration and Air Conditioning," Tata McGraw-Hill Publishers 1994
16) Ganesan V." Internal Combustion Engines", Third Edition, Tata McGraw-Hill 2007
17) Rudra Moorthy, R, "Thermal Engineering ", Tata McGraw-Hill, New Delhi,2003
18) Ramalingam. K.K., "Thermal Engineering", SCITECH Publications (India) Pvt. Ltd., 2009

MACHINE TOOL OPERATION

Semester: V

Course	Code	Credits	Total Hours - 40 Hours /Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
Machine Tool Operation	18ME531	03	03	00	50	50	03

COURSE OBJECTIVES

1. To introduce students to different machine tools in order to produce components having different shapes and sizes.
2. To enrich the knowledge pertaining to relative motion and mechanics required for various machine tools.
3. To develop the knowledge on mechanics of machining process and effect of various parameters on economics of machining.

MODULE-1 **(08 HOURS)**

INTRODUCTION TO MACHINE TOOLS

Introduction, Classification, construction and specifications of lathe, drilling machine, milling machine, boring machine, broaching machine, shaping machine, planing machine, grinding machine [Simple sketches showing major parts of the machines

MODULE-2 **(08 HOURS)**

MACHINING OPERATIONS

Introduction, Types of motions in machining, turning and Boring, Shaping, Planing and Slotting, Thread cutting, Drilling and reaming, Milling, Broaching, Gear cutting and Grinding, Machining parameters and related quantities. [Sketches pertaining to relative motions between tool and work piece only]

MODULE – 3 **(08 HOURS)**

CUTTING TOOL MATERIALS, FLUIDS &GEOMETRY

Introduction, desirable Properties and Characteristics of cutting tool materials, cutting tool geometry (Single point cutting tool, Twist drill bit & milling cutter), cutting fluids and its applications. Machining equations for cutting operations: Turning, Shaping, Planing, slab milling, cylindrical grinding and internal grinding, simple numerical.

MODULE – 4 (08 HOURS)

MECHANICS OF MACHINING PROCESSES

Introduction, Chip formation, Orthogonal cutting, Merchants model for orthogonal cutting, Oblique cutting, Mechanics of turning process, Mechanics of drilling process, Mechanics of milling process, Numerical problems

MODULE – 5(08 HOURS)

TOOL WEAR, TOOL LIFE& FINISHING

Introduction, tool wear mechanism, tool wear equations, tool life equations, effect of process parameters on tool life, machinability, Numerical problems. Surface finishing, Super finishing process, effect of machining parameters on surface finish, polishing, buffing operation and application.

COURSE OUTCOMES:

The student will be able to

	Course Outcomes	Course Level
CO1	Identify and explain the construction and specifications of different types of machine and tools used for various machining operations.	U
CO2	**Describe various machining processes pertaining to relative motions between tool & work piece.**	Ap
CO3	Discuss different cutting tool materials, tool nomenclature & surface finish.	Ap
CO4	Apply mechanics of machining process to evaluate machining time.	Ap
CO5	Analyze tool wear mechanisms and equations to enhance tool life and minimize machining cost	Ap
	Total Number Lecture hours	**50**

U*=Understanding Ap*=Application

TEXT BOOKS:

7. "Manufacturing Process-II", Dr.K.Radhakrishna, Sapna Book House,5th Revised Edition 2009.
8. "Manufacturing & Technology:",P.N.Rao, 3rd Ed., Tata McGraw
9. "Machine tools & operations", AnupGoel, Technical publications,2nd edition 2018.
10. "Machine tools and operations", Sagar M. Baligidad, Sunsatar publishers,1st edition 2017.
11. "Metal cutting and machine tool engineering", Pakirappa, Durga publishing house, 3rd edition 2015-16.
12. "Manufacturing process-2", Kestoor Praveen, Suggi publishing,5th edition 2013.

REFERENCE BOOKS:

7. "Process and Materials of Manufacturing", Roy A Lindberg, 4th Ed.PearsonEdu. 2006.

8. “Manufacturing Technology”, SeropeKalpakjian, Steuen. R. Sechmid,Pearson Education Asia, 5th Ed. 2006.
9. “Principles of metal casting”, Rechard W. Heine, Carl R. LoperJr., Philip C. Rosenthal, Tata McGraw Hill Education Private Limited Ed.1976
10. “Fundamental of Machining and Machine Tools”, Geoffrey Boothroyd and Winston A. Knight, CRC Taylor& Francis, Third Edition.
11. “All about Machine Tools”, Heinrich Gerling, New Age International Publishers revised 2nd Edition, 2006
12. “Metal cutting principles”, Milton C. Shaw, Oxford University Press, Second Edition,2005.

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

COMPUTATIONAL FLUID DYNAMICS

Semester: V

Course	Code	Credits	Total Hours - 40 Hours /Week		Assessment		Exam Duration in Hrs
			Lecture	Tutorial	SEE	CIE	
Computational Fluid Dynamics	18ME532	04	03	0	50	50	03

Course Objectives:

1. To study the CFD applications,
2. To describe grid generation and Body-fitted coordinate system
3. To describe Differentiate the FDM, FVM and FEM

MODULE-1

INTRODUCTION:

CFD Applications. Need for Parallel Computers in CFD algorithms. Models of flows. Substantial derivative, Divergence of velocity. Continuity, Momentum, and Energy Equations-Derivation in various forms. Integral versus Differential form of equations. Comments on governing equations. Physical boundary conditions. Forms of equations especially suitable for CFD work. Shock capturing, and shock fitting. 08 Hours

MODULE-2

MATHEMATICAL BEHAVIOUR OF PARTIAL DIFFERENTIAL EQUATIONS:

Classification of partial differential equations. Cramer Rule and Eigen value methods for classification. Hyperbolic, parabolic, and elliptic forms of equations. Impact of classification on physical and computational fluid dynamics. Case studies: steady inviscid supersonic flow, unsteady inviscid flow, steady boundary layer flow, and unsteady thermal conduction, steady subsonic inviscid flow. 08 Hours

MODULE-3

GRID GENERATION AND ADAPTIVE GRIDS:

Need for grid generation and Body-fitted coordinate system. Structured Grids-essential features. Structured Grid generation techniques- algebraic and numerical methods. Unstructured Grids-essential features. Unstructured Grid generation techniques- Delaunay-Voronoi diagram, advancing front method. Surface grid generation, multi-block grid generation, and meshless methods. Grid quality and adaptive grids. Structured grids adaptive methods and unstructured grids adaptive methods. 08 Hours

MODULE-4

DISCRETISATION & TRANSFORMATION:

Discretisation: Finite differences methods, and difference equations. Explicit and Implicit approaches. Unsteady Problem -Explicit versus Implicit Scheme. Errors and stability analysis. Time marching and space marching. Reflection boundary condition. Relaxation techniques. Alternating direction implicit method. Successive over relaxation/under relaxation. Second order Lax-Wendroff method, mid-point Leap frog method, upwind scheme, numerical viscosity, and artificial viscosity. 08 Hours

MODULE-5

FINITE VOLUME TECHNIQUE AND SOME APPLICATIONS:

Spatial discretisation- cell centered and cell vertex techniques (overlapping control volume, duel control volume). Temporal discretisation- Explicit time stepping, and implicit time stepping. Time step calculation. Upwind scheme and high-resolution scheme. Flux vector splitting, approximate factorisation. Artificial dissipation and flux limiters. Unsteady flows and heat conduction problems. Upwind biasing. 08 Hours

COURSE OUTCOMES:

The student will be able to

	Course Outcomes	**Course Level**
CO1	Differentiate the FDM, FVM and FEM	U
CO2	Perform the flow, structural and thermal analysis.	Ap
CO3	Utilize the discretization methods according to the application.	Ap
CO4	Need for grid generation and Body-fitted coordinate system	Ap
CO5	CFD Applications. Need for Parallel Computers in CFD algorithms	Ap

TEXT BOOKS:

1. Fletcher, C.A.J., "Computational Techniques for Fluid Dynamics", Springer, Berlin,2nd edition, 2002, ISBN-13: 978-3540543046

2. John D. Anderson, "Computational Fluid Dynamics", McGraw Hill, 2013, ISBN-13: 978-0070016859

REFERENCE BOOKS:

1. John F. Wendt, "Computational Fluid Dynamics - An Introduction", Springer, 3rd edition,2013

2. Charles Hirsch, "Numerical Computation of Internal and External Flows", Elsevier,1st edition, 2007, ISBN-13: 978-9381269428.

3. Klaus A Hoffmann and Steve T. Chiang. "Computational Fluid Dynamics for Engineers", Vols. I & II Engineering Education System, P.O. Box 20078, W. Wichita, K.S., 67208 - 1078 USA, 1993.

SCHEME OF EXAMINATION:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

TURBOMACHINES

Semester: V

Course	Code	Credits	Total Hours-50		Assessment		Exam Duration Hours
			Hours /Week				
			Lecture	Tutorial	SEE	CIE	
Turbomachines	18ME533	04	03	01	50	50	03

COURSE OBJECTIVES:

1. The main objective of these specialized courses is to familiarize the students with the main theories and tools for the interpretation of numerical and experimental results and the design techniques for advanced turbomachinery components.
2. The first part provides the basis for the more specialized studies in turbines or compressors in the second part of this course program. The formal lectures are completed with the aero design of advanced turbomachinery components to put the learned lessons into practice.
3. The targeted courses prepare the student for a position in a turbomachinery research center or the R&D department of a turbomachinery manufacturer.
4. To learn the working principles of Impulse and Reaction water turbines and also to study its velocity triangles. To study design parameters related to Turbines
5. To understand the concept of Centrifugal pumps and its construction. To understand MPSH and NPSH terms related to centrifugal pumps.
6. To study equations for specific speed of various turbines and pumps. To understand performance characteristics of various turbines and pumps.
7. To illustrate the concept of centrifugal compressor, Axial compressors. To understand various parameters related to rotodynamic air compressors.

MODULE: 1

Introduction: Fluid machines, classification of fluid machines, Definition of turbomachine, parts of turbomachines, Classification of turbomachine, Comparison with positive displacement machines, Dimensional analysis, Application of dimensional analysis to a general fluid flow, significance of Pie terms, Effect of Reynold's number, Unit quantities, Hydraulic model analysis, Application of first and second laws of thermodynamics to turbomachines, Efficiencies of turbomachines. Problems.

MODULE: 2

Energy exchange in Turbomachines: Euler's turbine equation, Alternate form of Euler's turbine equation, components of energy transfer, General Analysis of turbines (PGT): impulse, and reaction turbine, degree of reaction(R), efficiency and utilization factor, relation between degree of reaction and utilization factor.

Power absorbing turbomachine (PAT): Axial flow machine (axial flow compressor, blower, pumps) energy transfer, Degree of reaction (R), Radial Flow Machine (Centrifugal pumps, compressor, blowers) energy transfer, Degree of reaction (R), H-Q curve, types of centrifugal pump impeller, numerical.

MODULE: 3

Steam Turbines: Classification, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, Need and methods of compounding, multi-stage impulse turbine, expression for maximum utilization factor for two stage, numerical problems.

Reaction turbine – Parsons's turbine, condition for maximum utilization factor, reaction staging, problems.

MODULE: 4

Hydraulic Turbines: Introduction, classification of hydraulic turbine, heads and efficiencies of hydraulic turbines, Pelton wheel: its velocity triangles, construction, working, work done and proportions of Pelton wheel, numerical problems (Calculation of bucket dimensions, Number of buckets, Jet diameter, Wheel diameter, Jet ratio, Speed ratio, Number of jets, efficiency, Power, Discharge etc.), performance characteristics of turbine

Reaction Turbine: (Francis and Kaplan turbine): its velocity triangles, construction, working, work done and proportions of reaction turbine, Draft tube, types of draft tube, numerical problem (calculation of various efficiencies, Power, Discharge, Blade angles, Runner dimensions etc.).

MODULE: 5

Centrifugal Pumps: Introduction, types, construction and working of pump, velocity triangle, terminology of centrifugal pump, pump losses and efficiencies, work done by centrifugal pump, pre-rotation, slip and slip coefficient, minimum starting speed, Multistage pumps, casing of centrifugal pump, Cavitation, Maximum permissible suction head (MPSH) and Net positive suction head (NPSH). Priming. Methods of priming, performance characteristics of pumps.

Centrifugal Compressors: Stage velocity triangles, slip factor, power input factor, Stage work, Pressure developed, stage efficiency, Chocking, Stalling, surging and problems. Axial flow Compressors: Expression for pressure ratio developed in a stage, work done factor, efficiencies and Problems.

Course Outcomes:

At the end of this course, student will be able to

	COURSE OUTCOMES	COURSE LEVEL
CO1	**Understand the working concept of turbomachine and model studies.**	(L-1, L-2, L3)
CO2	**Understand the application and analysis of turbine.**	(L-1, L-2, L3, L-4)
CO3	Understand working principle of Impulse and Reaction turbine.	(L-1, L-2, L3, L-4)
CO4	Understand the concept of Centrifugal pumps and various efficiencies related to it.	(L-1, L-2, L3, L-4)
CO5	Understand the concept of centrifugal and Axial compressors.	(L-1, L-2, L3, L-4)
	Total Number Lecture Hours	**50**
	NOTE: All levels mentioned are as per Bloom's Taxonomy	

TEXT BOOKS:

1. **"**Turbo machines", S.M. Yahya, Tata Mc Graw Hill, 2005
2. "Fans, compressor and turbine", S. M. Yahya, Tata Mc Graw Hill, 2005

REFERENCES:

19) Hydraulic Machines", V.P. Vasantdani, Khanna Publishers, 1996.2. "Fluid flow machines", N.S. Govind Rao, Tata McGraw-Hill,1983.
20) "Steam and gas Turbines", R. Yadav, Central Publishing House, Allahabad, 6th Edition, 1997.
21) "Gas Turbines", V. Ganeshan, Published by TMH Education Pvt. Ltd., 3rd Edition.
22) "Thermal Engg.", Kumar vasantdani, Khanna publisher
23) "Thermal Engg.", P.L. Balleny, Khanna publisher. , 20th Edition
24) "Gas turbines and Compressor", Cohen and Rogers, Saravanamutto Publisher

25) "Thermodynamics and Heat Engines", R. Yadav, Vol-II, Central Publishing House.
26) "Fluid mechanics and hydraulic machines", Modi and Seth, Standard Book House, 2004
27) "Thermal Engineering", R K Rajput, Laxmi Publication.
28) "Fluid Mechanics and Hydraulic Machines", S.C. Gupta, Pearson Education, 1st Edition
29) "Fluid Mechanics and hydraulic machines",R. K. Rajput, S. Chand Publication.
30) "Fluid Mechanics and hydraulic machines",R. K. Bansal, L.P. Pub. House.

COMPOSITE MATERIAL TECHNOLOGY

SEMESTER: V

Course	Code	Credits	Total Hours - 40 Hours /Week		Assessment		Exam Duration in Hrs.
			Lecture	Tutorial	SEE	CIE	
Composite material technology	18ME534	03	03	00	50	50	03

Course objectives: The objectives of this course is to

1. Composite materials technology provides fundamental knowledge to composite material, classifications of composite materials based on matrix and reinforcements.
2. It gives basic information of manufacturing methods and also gives information of mechanical properties, geometrical aspects of composite materials.

MODULE-1

INTRODUCTION TO COMPOSITES

Definition, Composite Types of matrices and reinforcements, Types of composites, Carbon Fibre composites, Properties of composites in comparison with standard materials, Applications of metal, ceramic and polymer matrix composites.

08 Hours

MODULE-2

FIBER REINFORCED PLASTIC PROCESSING

Hand and spray lay - up, injection molding, resin injection, filament winding, pultrusion, blow molding, centrifugal casting and prepregs. Fibre/Matrix Interface, mechanical. **08 Hours**

MODULE-3

METAL MATRIX COMPOSITES

Reinforcement materials, types, Characteristics and selection and base metals – Need for production and MMC's. Fabrication process for MMC's: Powder metallurgy technique, liquid metallurgy technique and secondary processing, special fabrication techniques. **08 Hours**

MODULE-4

STUDY OF PROPERTIES FOR MMC'S

physical mechanical, wear, machinability and other properties. Effect of size, shape, and distribution of particulate on properties. **08 Hours**

MODULE-5

APPLICATIONS OF COMPOSITES

Automobile, Aircraft's, missiles, space hardware, electrical and electronics, marine, recreational and sports equipment, future potential of composites. **08 Hours**

COURSE OUTCOMES: The student will be able to

1. Develop basic fundamental understanding of the composite materials and structures and selection of materials in aerospace, mechanical engineering structures.
2. Learn about the different types of manufacturing methods of composite materials
3. Learn about the joining methods and failures.

TEXT BOOKS:

1. Composite Materials handbook, Mein Schwartz Mc Graw Hill Book Company, 1984.
2. Mechanics of composite materials, Autar K. Kaw CRC Press New York.

REFERENCE BOOKS:

1. Mechanics of Composite Materials, Rober M. Joness Mc-Graw Hill Kogakusha Ltd.
2. Stress analysis of fiber Reinforced Composite Materials, Michael W, Hyer Mc-Graw Hill International.
3. Composite Material Science and Engineering, Krishan K. Chawla Springer.
4. Fibre Reinforced Composites, P.C. Mallik Marcel Decker.

SCHEME OF EXAMINATION:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

REFRIGERATION AND AIR-CONDITIONING

Semester: V

Course	Code	Credits	Total Hours-50 Hours /Week		Assessment		Exam Duration Hours
			Lecture	Tutorial	SEE	CIE	
Refrigeration and Air -Conditioning	18ME541	04	03	01	50	50	03

COURSE OBJECTIVES:

1. Study the basic definition, ASHRAE nomenclature for refrigerating systems
2. Understand the working principles and application of different types of refrigeration system
3. Study the working of air conditioning system and their applications
4. Identify the performance parameters and their relations of an air conditioning system.

MODULE: 1

Introduction to Refrigeration –Basic Definitions, ASHRAE Nomenclature, Air Refrigeration, Cycles-reversed Carnot cycle, Bell-Coleman cycle analysis, Air Refrigeration systems-merits and, demerits and applications: Aircraft refrigeration cycles, Joule Thompson coefficient and Inversion Temperature, Linde, Claude and Stirling cycles for liquefaction of air.

Industrial Refrigeration- Chemical and process industries, Dairy plants, Petroleum refineries, Food processing and food chain, Miscellaneous

10 Hours

MODULE: 2

Vapour Compression Refrigeration System (VCRS): Comparison of Vapour Compression Cycle and Gas cycle, Vapour Compression Refrigeration System Working and analysis, Limitations, Superheat horn and throttling loss for various refrigerants, efficiency, Modifications to standard cycle – liquid-suction heat exchangers, Grindlay cycle and Lorenz cycle, Optimum suction condition for optimum COP – Ewing's construction and Gosney's method.

Actual cycles with pressure drop, Complete Vapour Compression Refrigeration System, Multi-Pressure, Multi-evaporator systems or Compound Vapour Compression Refrigeration Systems – Methods like Flash Gas removal, Flash inter cooling and water Inter cooling

10 Hours

MODULE: 3

Vapour Absorption Refrigeration Systems: Absorbent – Refrigerant combinations, WaterAmmonia Systems, Practical problems, Lithium- Bromide System, Contrast between the

two systems, Modified Version of Aqua-Ammonia System with Rectifier and Analyzer Assembly.

Practical problems – crystallization and air leakage, Commercial systems other types of Refrigeration systems: Brief Discussion on (i) Steam-Jet refrigeration system and (ii) Thermoelectric refrigeration, pulse tube refrigeration, thermo acoustic refrigeration systems.

10 Hours

MODULE: 4

Refrigerants: Primary and secondary refrigerants, Designation of Refrigerants, Desirable properties of refrigerants including solubility in water and lubricating oil, material compatibility, toxicity, flammability, leak detection, cost, environment and performance issues Thermodynamic properties of refrigerants, Synthetic and natural refrigerants, Comparison between different refrigerants vis a vis applications, Special issues and practical implications Refrigerant mixtures – zeotropic and a zeotropic mixtures Refrigeration systems Equipment: Compressors, Condensers, Expansion Devices and Evaporators.

10 Hours

MODULE: 5

Air-Conditioning: Introduction to Air-Conditioning, Basic Definition, Classification, power rating, ASHRAE Nomenclature pertaining to Air-Conditioning, Applications of Air-Conditioning, Mathematical Analysis of Air-Conditioning Loads, Related Aspects, Different Air-Conditioning Systems-Central – Station Air-Conditioning System, Unitary Air-Conditioning System, Window Air Conditioner and Packaged Air Conditioner, Components related to Air-Conditioning Systems. Transport air conditioning Systems: Air conditioning systems for automobiles (cars, buses etc.), Air conditioning systems for trains, Air conditioning systems for ships. **10 Hours**

COURSE OUTCOMES

At the end of this course, student will be able to

	COURSE OUTCOMES	COURSE LEVEL
CO1	Illustrate the principles, nomenclature and application of refrigeration system	**(L-1, L-2, L3)**
CO2	Explain vapour compression refrigeration system and identify methods for performance	**(L-1, L-2, L3, L-4)**
CO3	Study the working principle of air, vapour absorption, thermoelectric and steam – jet and thermo-acoustic refrigeration system	**(L-1, L-2, L3, L-4)**
CO4	Estimate the performance of air -conditioning system using the principles of psychometry.	**(L-1, L-2, L3, L-4)**
CO5	**Compute and interpret cooling and heating loads in an air conditioning system and identify suitable refringent for various refrigerating system.**	**(L-1, L-2, L3, L-4)**
	Total Number Lecture Hours	**50**
	NOTE: All levels mentioned are as per Bloom's Taxonomy	

TEXT BOOKS:

31) Roy J. Dossat, Principles of Refrigeration, Wiley Limited

32) Arora C.P., Refrigeration and Air-conditioning, Tata Mc Graw –Hill, New Delhi, 2nd Edition,2001.

33) Stoecker W.F., and Jones J.W., Refrigeration and Air-conditioning, Mc Graw - Hill, New Delhi 2nd edition, 1982.

REFERENCES:

1. Dossat, Principles of Refrigeration Pearson-2006.
2. McQuistion, Heating, Ventilation and Air Conditioning, Wiley Students edition, 5th edition 2000.
3. PITA, Air conditioning 4rth edition, pearson-2005
4. Refrigeration and Air-Conditioning' by Manohar prasad
5. S C Arora& S Domkundwar, Refrigeration and Air-Conditioning Dhanpat Rai Publication

DATA BOOK:

1. Shan K. Wang, Handbook of Air Conditioning and Refrigeration, 2/e, 2001 McGraw-Hill, Education
2. Mathur M.L. & Mehta, Refrigerant and Psychrometric Properties (Tables & Charts) SI Units, F.S., Jain Brothers,2008

SUPPLY CHAIN MANAGEMENT

Semester: V

Course	Code	Credits	Total Hours - 40 Hours /Week		Assessment		Exam Duration in Hrs
			Lecture	Tutorial	SEE	CIE	
SCM	18ME542	04	04	00	50	50	03

COURSE OBJECTIVES

1.Demonstrate operational purchasing methods and techniques on supplier management and supply in specific business contexts.

2. To provide an insight into the role of internet technologies and electronic commerce in supply chain operations and to discuss technical aspects of key ITEC components in supply chain management.

Module 1 Introduction to SCM:

Basic concepts & philosophy of SCM, essential features, decision phases – process view, supply chain framework, key issues in SCM and benefits.

8 Hours

Module 2 Designing the supply chain network:
Designing the distribution network, role of distribution, factors influencing distribution, design options, distribution networks in practice, network design in the supply chain, factors affecting the network design decisions. Designing and Planning Transportation Networks, role of transportation, modes, design options, tailored transportation. **8 Hours**

Module 3 Inventory Management & Recent issues in SCM:
Concept, various costs associated with inventory, EOQ, buffer stock, lead time reduction, reorder point / re-order level fixation, ABC analysis, SDE/VED Analysis.
Recent issues in SCM Role of computer/ IT in supply chain management, CRM Vs SCM, Benchmarking concept, features and implementation, outsourcing – basic concepts, value addition in SCM. **8 Hours**

Module 4 Purchasing and vendor management:

Centralized and decentralized purchasing, functions and purchase policies, vendor rating/ evaluation, single vendor concept, account for materials, just in time & Kanban systems of inventory management. **8 Hours**

Module – 5 Logistics Management:

Logistics of part of SCM, logistics costs, logistics, sub-systems, inbound and out bound logistics bullwhip effects in logistics, distribution and warehousing management. Demand Management and Customer Service: Demand Management, CPFRP, customer service, expected cost of stock outs. 8 **Hours**

COURSE OUTCOMES:

The student will be able to:

	Course Outcomes	Course Level
CO1	Demonstrate knowledge of the functions of logistics and supply chain management.	U
CO2	To relate concepts and activities of the supply chain to actual organizations.	AP
CO3	Highlight the role of technology in logistics and supply chain management.	AP
CO4	Evaluate cases for effective supply chain management and its implementation.	AP
CO5	Describe the basic part of SCM and demand management	AP

TEXT BOOKS:

1. A Logistic approach to Supply Chain Management – Coyle, Bardi, Longley, 1st Edition, Cengage Learning.
2. Supply Chain Logistics Management, Donald J Bowersox, Dand J Closs, M Bixby Coluper,2nd Edition, TMH, 2008.

REFERENCE BOOKS:

1. Supply chain management, Chopra Sunil and Peter Meindl - 3rd edition, Pearson, 2007.

2. Supply Chain Management-A Managerial Approach, Amith Sinha, Herbert, 2nd edition, TMH.

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

ALTERNATIVE FUELS FOR TRANSPOTATION

SEMESTER: -V

Course	Code	Credits	Total Hours - 40		Assessment		Exam Duration in hrs.
			Hours /Week				
			Lecture	Tutorial	SEE	CIE	
AFT	18ME543	04	04	00	50	50	03

Course objectives: The objectives of this course is to

1. Describe need for alternative fuels for internal combustion engine and alternative drive systems for automobiles
2. Describe principle of solar energy collection, construction of photo voltaic cells
3. Explain various properties, methods of production of Bio gas, methanol, ethanol, SVO, Bio diesel
4. Explain use of hydrogen for internal combustion engine application.
5. Describe use of various gaseous fuels for internal combustion engine application.
6. Understand various aspects of electrical and Hybrid vehicles

MODULE-I (08 Hours)

INTRODUCTION: Types of energy sources, their availability, need of alternative energy sources, non-conventional energy sources, Classification of alternative fuels and drive trains. Scenario of conventional auto fuels, oil reserves of the world. Fuel quality aspects related to emissions. Technological up gradation required business driving factors for alternative fuels. Implementation barriers for alternative fuels. Stakeholders of alternative fuels, roadmap for alternative fuels. Solar energy: Solar energy geometry, solar radiation measurement devices. Solar energy collectors, types of collectors. Direct application of solar energy, solar energy storage system. P. V. effect solar cells and characteristics. Application of solar energy for automobiles.

MODULE-II (08 Hours)

BIOGAS: History, properties and production of Biogas, classification of biogas plants, biogas storage and dispensing system. Advantages of biogas, hazards and emissions of biogas. Production, properties, Engine performance, advantages and disadvantages of Methanol, Ethanol, Butanol, Straight vegetable oil, Biodiesel for internal combustion engine application.

MODULE-III (08 Hours)

HYDROGEN: Properties and production of hydrogen, Storage, Advantages and disadvantages of hydrogen, use of Hydrogen in SI and CI engines. Hazards and safety systems for hydrogen, hydrogen combustion. Emission from hydrogen. Gaseous fuels: 08 Hours Production, properties, Engine performance, advantages and disadvantages of CNG, LNG, ANG, LPG and LFG.

MODULE-IV (08 Hours)

REFORMULATED CONVENTIONAL FUELS: Introduction. Production of coal water slurry, properties, as an engine fuel, emissions of CWS. RFG, Emulsified fuels. Hydrogen-enriched gasoline. Future Alternative Fuels: Production, properties, Engine performance, advantages and disadvantages of PMF, Ammonia, Liquid-Nitrogen, Boron, Compressed Air, Water as fuel for Internal combustion Engine.

MODULE-V (08 Hours)

ALTERNATIVE POWER TRAINS: Components of an EV, EV batteries, chargers, drives, transmission and power devices. Advantages and disadvantages of EVs. Hybrid electric vehicles, HEV drive train components, advantages of HV. History of dual fuel technology, Applications of DFT. Dual fuel engine operation. Advantages and disadvantages of dual fuel

technology.

COURSE OUTCOMES: The student will be able to

	Course Outcomes	Course Level
CO1	Describe need for alternative fuels for internal combustion engine and alternative drive systems for automobiles	U
CO2	Describe principle of solar energy collection, construction of photo voltaic cells	AP
CO3	Explain various properties, methods of production of Bio gas, methanol, ethanol, SVO, Bio diesel	AP
CO4	Explain use of hydrogen for internal combustion engine application.	AP
CO5	Describe use of various gaseous fuels for internal combustion engine application.	AP
CO6	Explain various aspects of electrical and Hybrid vehicles	AP
	Total Number Lecture hours	**40**

Text Books: 1. Alternative Fuels- S.S. Thipse. JAICO Publishing House. 2. Non-Conventional Energy Sources- G. D. Rai Khanna Publishing New Delhi

Reference Books: 1. Alternative fuels for Vehicle - M. Poulton

2. Alternative fuels guide - R. Bechtold.SAE

3. Alternative energy sources -T. N Veziroglu, McGraw Hill

4. A Primer on Hybrid Electric vehicles

5. Automotive Fuels Guide - Richard L. Bechtold, SAE Publications, 1997

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

MICRO ELECTROMECHANICAL SYSTEM

Semester: V

Course	Code	Credits	Total Hours - 40 Hours /Week		Assessment		Exam Duration in Hrs
			Lecture	Tutorial	SEE	CIE	
MEMS	18ME544	04	04	00	50	50	03

COURSE OBJECTIVES

1.To provide detailed information about the basics of MEMS and Micro fabrication processes.

2.To impart knowledge of various sensing, actuation of materials and build adequate knowledge of polymer MEMS, Micro Fluids and some case studies.

Module 1 Introduction to MEMS:

History of MEMS, Intrinsic Characteristics, Devices: Sensors and Actuators. Micro fabrication: Photolithography, Thermal oxidation, thin film deposition, etching types, Doping, Dicing, Bonding. Microelectronics fabrication process flow, Silicon based Process selection and design.

8 Hours

Module 2 Piezoelectric Sensing and Actuation:

Introduction, Cantilever Piezoelectric actuator model, Properties of Piezoelectric materials, Applications. Magnetic Actuation: Concepts and Principles, Magnetization and Nomenclatures, Fabrication and case studies, Comparison of major sensing and actuation methods. **8 Hours**

Module 3 Polymer MEMS:

Introduction, Polymers in MEMS (Polyimide, SU-8, LCP, PDMS, PMMA, Parylene, Others) Applications (Acceleration, Pressure, Flow, Tactile sensors). **8 Hours**

Module 4 Micro fluidics:

Motivation for micro fluidics, Biological Concepts, Design and Fabrication of Selective components. Channels and Valves. **8 Hours**

Module – 5 Case Studies:

MEMS Magnetic actuators, BP sensors, Microphone, Acceleration sensors, Gyro, MEMS Product development: Performance, Accuracy, Repeatability, Reliability, Managing cost,

Market uncertainties, Investment and competition. 8 **Hours**

COURSE OUTCOMES:

The student will be able to

	Course Outcomes	**Course Level**
CO1	Describe the sensors and actuators, basics of fabrication process.	U
CO2	Describe the Knowledge of piezoelectric, actuation of materials and magnetic actuation.	AP
CO3	Describe the polymers in MEMS and its applications.	AP
CO4	Describe the concepts of the micro fluidics and fabrication process.	AP
CO5	Learn some case studies on MEMS and uncertainty in the market.	AP

TEXT BOOKS:

3. Foundation of MEMS, by Chang Liu. Pearson Education. (ISBN:9788131764756).

4. "Micro and Smart Systems" by Dr. A.K.Aatre, Prof. Ananth Suresh, Prof.K.J.Vinoy, Prof. S. Gopala krishna,, Prof. K.N.Bhat.,John Wiley Publications.

5. MEMS & Microsystems: Design and Manufacture, Tai-Ran Tsu, Tata Mc-Graw-Hill.

REFERENCE BOOKS:

1. Analysis and Design Principles of MEMS Devices, Minhang Bao, Elsevier, Amsterdam, the Netherlands, ISBN 0-444-51616-6.

2. Design and Development Methodologies, Smart Material Systems and MEMS: V. Varadan, K. J. Vinoy, S. Gopalakrishnan, Wiley.

3. MEMS- Nitaigour Premchand Mahalik, TMH 2007

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

FLUID MACHINERY LAB

Semester: V

Course	Code	Credits	Total Hours - 24 Hours /Week		Assessment		Exam Duration in Hrs
			Lecture	Practical	SEE	CIE	
Fluid Machinery Lab	18MEL55	01	00	02	50	50	03

OBJECTIVES:

1. To gain knowledge in performance testing of Hydraulic Turbines and Hydraulic Pumps at constant speed and Head.
2. To provide practical knowledge in verification of principles of fluid flow.
3. Enrich the concept of fluid mechanics and hydraulic machines.
4. Demonstrate the classical experiments in fluid mechanics and hydraulic machinery.
5. Discuss the performance characteristics of turbines and pumps.

LIST OF EXPERIMENTS:

PART-A

1) To determine total head, pump output, overall efficiency and pump efficiency of Gear Pump Test Rig.
2) To determine total head, pump output, overall efficiency and pump efficiency of the submersible pump of Submersible Pump Test Rig
3) To find out discharge of useful water and waste water. To find out the efficiency of the Hydraulic ram of Hydraulic Ram Test Rig,
4) To determine total head, pump output, overall efficiency and pump efficiency of the Jet pump
5) Pipes in Parallel and series, to study the pipes in parallel and series.

PART-B

6) Performance on hydraulic Turbines
    a. Pelton wheel
    b. Francis Turbine
    c. Kaplan Turbines
7) Performance hydraulic Pumps
    d. Single stage and Multi stage centrifugal pumps
    e. Reciprocating pump

8) Performance test on a two stage Reciprocating Air Compressor
9) To show the velocity and pressure variation with radius in a forced vortex flow

OUT COMES:

4) Ability to use the measurement equipments for flow measurement.
5) The students will be able to understand the performance of hydraulic turbine and pumps under different working conditions
6) Able to develop the skill of experimentation techniques for the study of flow phenomena in channels/pipes.
7) To provide the students' knowledge in calculating performance analysis in turbines and pumps and can be used in power plants.
8) Students can able to understand to analyze practical problems in all power plants and chemical industries
9) Given the required flow rate and pressure rise, select the proper pump to optimize the pumping efficiency

Scheme of Examination:

ONE question from part -A: 40 Marks
ONE question from part -B: 40 Marks
Viva -Voice: 20 Marks
Total: 100 Marks

MACHINE SHOP LAB

Semester: V

Course	Code	Credits	Total Hours - 24 Hours /Week		Assessment		Exam Duration in Hours
			Lecture	Practical	SEE	CIE	
Machine Shop Lab	18MEL56	01	00	02	50	50	03

COURSE OBJECTIVES

1. To provide an insight to different machine tools, accessories and attachments.
2. To train students into machining operations to enrich their practical skills.
3. To inculcate team qualities and expose students to shop floor activities.
4. To educate students about ethical, environmental and safety standards.

PART-A

Preparation of three models on lathe involving: Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning.

PART-B

Cutting of V Groove/ dovetail / Rectangular groove using a shaper.

Cutting of Gear Teeth using Milling Machine.

COURSE OUTCOMES:

The student will be able to

	Course Outcomes	Course Level
CO1	Identify the parts of machines and differentiate different types of machine and tools in machine shop.	U
CO2	Machine and tool setup for various machining operations.	U
CO3	Perform various machining operations to change the shape of a given workpiece-Facing, drilling, turning, threading cutting knurling etc.	Ap
CO4	Understand the safety precautions during machining processes.	U
CO5	Perform operations on lathe, milling and shaper for various engineering applications.	Ap

U*=Understanding Ap*=Application

SCHEME OF EXAMINATION:

One Model from Part – A 50 Marks
One Model from Part – B 30 Marks
Viva Voce 20 Marks
Total 100 Marks

DESIGN LAB / MACHINE DYNAMICS LAB

Semester: V

Course	Code	Credits	Total Hours - 24 Hours /Week		Assessment		Exam Duration in hrs
			Lecture	Practical	SEE	CIE	
DESIGN LAB / MACHINE DYNAMICS LAB	18MEL57	01	00	02	50	50	03

COURSE OBJECTIVES

- To understand the natural frequency, logarithmic decrement, damping ratio and damping.
- To understand the balancing of rotating masses.
- To understand the concept of the critical speed of a rotating shaft.
- To understand the concept of stress concentration using Photo elasticity.
- To understand the equilibrium speed, sensitiveness, power and effort of Governor.

PART - A

1. Determination of natural frequency, logarithmic decrement, damping ratio and damping Co-efficient in a single degree of freedom vibrating systems (longitudinal and torsional)
2. Determination of critical speed of rotating shaft.
3. Balancing of rotating masses.
4. Determination of fringe constant of Photo-elastic material using Circular disk subjected diametric compression, Pure bending specimen (four-point bending)
5. Determination of stress concentration using Photo elasticity for simple components like Plate with hole under tension or bending, circular disk with circular hole under compression, 2-d crane Hook

PART – B

1. Determination of equilibrium speed, sensitiveness, power and effort of Porter/ Proel / Hartnell Governor. (at least one)
2. Determination of principle stresses and strain in a member subjected to combined loading using strain rosettes.
3. Determination of stresses in curved beam using strain gauge
4. Experiments on Gyroscope
5. Experiment on Journal bearing ((Demonstration only)

Course outcomes:
On completion of this subject, students will be able

	Course Outcomes	Course Level
CO1	To understand the working principles of machine elements such as Governors, Gyroscopes etc.,	**U**
CO2	To identify forces and couples in rotating mechanical system components.	**AP**
CO3	To identify vibrations in machine elements and design appropriate damping methods and to determine the critical speed of a rotating shaft.	**AP**
CO4	To measure strain in various machine elements using strain gauges.	**AP**
CO5	To determine the minimum film thickness, load carrying capacity, frictional torque and pressure distribution of journal bearing.	**AP**
CO6	To determine strain induced in a structural member using the principle of photo-elasticity.	**AP**

U* = Understanding. AP* = Application

REFERENCE BOOKS:

[1] "Shigley's Mechanical Engineering Design", Richards G. Budynas and J. Keith Nisbett, McGraw-Hill Education, 10th Edition, 2015.

[2] "Design of Machine Elements", V.B. Bhandari, TMH publishing company Ltd. New Delhi, 2nd Edition 2007.

[3] "Theory of Machines", Sadhu Singh, Pearson Education, 2nd Edition, 2007.

[4] "Mechanical Vibrations", G.K. Grover, Nem Chand and Bros, 6th Edition, 1996

SCHEME OF EXAMINATION:

Scheme of Examination:
One question from Part A: 50 Marks
One question from part B: 30 Marks
Viva- Voce: 20Marks
Total: 100 Mark

MINI PROJECT-V

Semester: V

Course	Code	Credits	Total Hours - 24		Assessment		Exam Duration in Hrs
			Hours /Week				
			Lecture	Practical	SEE	CIE	
Mini project-V	18MEMP58	01	00	02	50	50	02

OBJECTIVES:

To introduce fundamental concepts and analysis techniques in engineering to students across all disciplines.

Mini-project work:

Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.

PROFESSIONAL ETHICS

Semester: V

Course	Code	Credits	Total Hours – 10 Hours /Week		Assessment		Exam Duration in hours
			Lecture	Tutorial	SEE	CIE	
Professional Ethics	18HSM59	01	01	00	50	50	03

OBJECTIVES:

- To enable the students to create an awareness on Engineering Ethics and Human Values,
- To instill Moral and Social Values and Loyalty and to appreciate the rights of others.

UNIT I HUMAN VALUES

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self-confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

UNIT II ENGINEERING ETHICS

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination

UNIT V GLOBAL ISSUES

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility

Upon completion of the course, the student should be able to apply ethics in society, discuss the ethical issues related to engineering and realize the responsibilities and rights in the society

TEXTBOOKS:

1. Mike W. Martin and Roland Schinzinger, “Ethics in Engineering”, Tata McGraw Hill, New Delhi, 2003. 2. Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, Prentice Hall of India, New Delhi, 2004.

REFERENCES:

1. Charles B. Fleddermann, “Engineering Ethics”, Pearson Prentice Hall, New Jersey, 2004.
2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, “Engineering Ethics – Concepts and Cases”, Cengage Learning, 2009
3. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003
4. Edmund G Seebauer and Robert L Barry, “Fundametals of Ethics for Scientists and Engineers”, Oxford University Press, Oxford, 2001
5. Laura P. Hartman and Joe Desjardins, “Business Ethics: Decision Making for Personal Integrity and Social Responsibility” Mc Graw Hill education, India Pvt. Ltd.,New Delhi 2013.
6. World Community Service Centre, " Value Education", Vethathiri publications, Erode, 2011

THEORY OF MACHINES

Semester: VI

Course	Code	Credits	Total Hours - 40		Assessment		Exam Duration in Hrs
			Hours /Week				
			Lecture	Tutorial	SEE	CIE	
Theory of Machines	18ME61	03	03		50	50	03

COURSE OBJECTIVES

3. To provide detailed information about the basics mechanisms and knowledge of various forces acting on mechanisms.
4. To impart knowledge of velocity and force analysis and balancing of masses.
5. To provide basic knowledge of governors and gyroscope and its applications,
6. To impart knowledge of vibrations and its applications.

Module-1

Introduction: Definitions: Link, kinematic pairs, kinematic chain, mechanism, structure, degrees of freedom, Classification links, Classification of pairs based on type of relative motion,Grubler's criterion, mobility of mechanism, Groshoff's criteria.

Mechanisms: Quick return motion mechanisms-Drag link mechanism, Whitworth mechanism and Crank and slotted lever Mechanism. Oldham's coupling, Straight line motion mechanisms Peaucellier's mechanism and Robert's mechanism. Intermittent Motion mechanisms: Geneva wheel mechanism, Ratchet and Pawl mechanism, toggle mechanism, pantograph, condition for correct steering, Ackerman steering gear mechanism.

10 hours

MODULE -2

Velocity Analysis by Instantaneous Center Method: Definition, Kennedy's theorem, Determination of linear and angular velocity using instantaneous center method.

Klein's Construction: Analysis of velocity and acceleration of single slider crank mechanism.

6 hours

MODULE – 3

Static force Analysis: Static equilibrium. Equilibrium of two and three force members. Members with two forces and torque, free body diagrams, Static force analysis of four bar mechanism and Slider-crank mechanism with and without friction.

Balancing of Rotating Masses: Static and dynamic balancing, balancing of single rotating mass by balancing masses in same plane and in different planes. Balancing of several rotating masses by balancing masses in same plane and in different planes. 14 hours

MODULE – 4

Governors: Types of governors, force analysis of Porter and Hartnell governors. Controlling force, Stability, Sensitiveness, Isochronism, Effort and Power. Gyroscope: Vectorial representation of angular motion,

Gyroscopic couple. Effect of gyroscopic couple on plane disc, aero plane, ship, stability of two wheelers and four wheelers, numerical problems. 10 hours

MODULE – 5

Introduction & Undamped free Vibrations (Single Degree of Freedom)

Types of vibrations, Definitions, Simple Harmonic Motion (SHM), Work done by harmonic force, Principle of super position applied to SHM. Derivations for spring mass systems, Natural frequencies of simple systems, springs in series and parallel, Tensional and transverse vibrations, Effect of mass of spring and problems.

Vibration measuring instruments.Sesmi instruments, Vibrometers, Accelerometer, Frequency measuring instruments, and simple numelericals. 10 hours

COURSE OUTCOMES:

The student will be able to

	Course Outcomes	**Course Level**
CO1	Describing the basic knowledge of different links, pair, chain, mechanism, structure and DOF. Describing the mechanisms like Quick return motion mechanisms, Straight line motion mechanisms, Intermittent Motion mechanisms, and steering gear mechanism.	U
CO2	Describing the Velocity Analysis by Instantaneous Center Method and Klein's Construction.	Ap
CO3	Analyzing the Static force Analysis, and balancing of rotating masses in single plane and also in different planes.	Ap
CO4	Study of governors and gyroscope	Ap
CO5	Study of vibrations and vibration measuring instruments.	Ap
	Total Number Lecture hours	**50**

TEXT BOOKS:

13. Theory of Machines, Sadhu Singh, Pearson Education, 2nd Edition. 2007.
14. Mechanism and Machine Theory, A. G. Ambekar PHI, 2007
15. Mechanical Vibrations, V. P. Singh, Dhanpat Rai and Company,
16. Mechanical Vibrations, G. K.Grover, Nem Chand and Bros.
17. Rattan S.S, Theory of Machines,Tata McGraw-Hill Publishing Company Ltd., New Delhi, 4th Edition, 2014.
18. Ambekar A. G., Mechanism and Machine Theory, PHI, 2009.

REFERENCE BOOKS:

1. Theory of Machines, Rattan S.S. Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition, 2009.
2. Mechanical Vibrations, S. S. Rao, Pearson Education Inc, 4edition, 2003.
3. Michael M Stanisic, Mechanisms and Machines-Kinematics, Dynamics and Synthesis, Cengage Learning, 2016.
4. Sadhu Singh, Theory of Machines, Pearson Education (Singapore)Pvt. Ltd, Indian Branch New Delhi, 2nd Edi. 2006.

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

DESIGN OF MACHINE ELEMENTS

Semester: VI

Course	Code	Credits	Total Hours - 40 Hours /Week		Assessment		Exam Duration in Hrs
			Lecture	Tutorial	SEE	CIE	
Design of Machine Elements	18ME62	04	03	01	50	50	03

Course Objectives: The course aims:

1) Study basic principles of machine design.

2) Understand the principles involved in evaluating the dimensions of a component to satisfy functional and strength requirements.

3) Learn use of catalogues and design data book.

4) Design machine elements subjected to fluctuating loading.

MODULE 1

Fundamentals of Machine Design , Concept of Machine design, Types of loads, Factor of safety- its selection and significance, Review of theories of elastic failure and their applications, Basic procedure of design of machine elements,

Review and selection of various engineering material properties and I.S. coding for ferrous materials, Factors governing selection of Engineering materials.

MODULE 2

Design of machine elements under static loading- Knuckle joint, Turn buckle and bell crank Lever.

Types of Couplings, Design of Muff, Rigid Coupling, flexible bushed pin type flanged coupling.

MODULE 3

Design of Pulley and Selection of Belts Design of Pulley- flat and V belt pulley, Selection of flat belt, V belt as per the standard manufacturer's catalogue, Introduction to timing belts.

MODULE 4

Introduction to Gears Gear terminology, Material selection, Types of gear failure.

Spur Gear Gear tooth loads, No. of teeth, Face width, Strength of gear teeth, Static beam strength (Lewis equation) Barth equation, Dynamic tooth load (spot's equation and Buckingham equation), Wear strength (Buckingham's equation), Estimation of module based on beam strength and wear strength. Gear design for maximum power transmission capacity,

Helical Gears Formative number of teeth in helical gears, Force analysis, Beam and wear strength of helical gears, Effective load and design of helical gear.

MODULE 5

Bevel Gear Straight tooth bevel gear terminology and geometrical relations, Guidelines for selection of dimensions and minimum number of teeth, Force analysis,

Beam and wear strength, Dynamic tooth load, Design of straight tooth bevel gears based on beam and wear strength,

Worm Gears Terminology and geometrical relations. Standard dimensions and recommendation of worm gearing, Force analysis, Friction, Efficiency of worm gear drive, Design of worm drive based on beam strength and wear strength rating, Thermal consideration in worm drive.

COURSE OUTCOMES:

The student will be able to

	Course Outcomes	Course Level
CO1	. Apply basic principles of machine design	U
CO2	Design machine elements subjected to fluctuating loading.	Ap
CO3	Design machine elements on the basis of strength concept.	Ap
CO4	Select machine elements from Manufacturer's catalogue.	Ap
CO5	Design various types of gears such as spur, helical, bevel and worm gear.	Ap

TEXT BOOKS:

1)"Design of Machine Elements",V.B.Bhandari., Tata McGraw Hill Publication, 3rd Edition.

2) "Machine Design", R.K.Jain, Khanna Publication.

3) "Machine Design", Pandya Shah, Charotar Publication.

4) "Design of Machine Elements", P. Kannaiah, Scitech Publication.

5) "Machine Design A Basic Approach", Dr. S.S.wadhwa S S Jolly Dhanapat Rai and Sons.

6) "Machine Design", U.C.Jindal, Pearson Education.

7) "Design of Machine ElementsI & II", J.B.K.Das and P.L.S. Murthy, Sapna Publishers, 2nd Edition

REFERENCE BOOKS:

1) "Machine Design",Hall, Holowenko Laughlin, Tata McGraw Hill Publication Schaums Outline Series.

2) "Design of Machine Element", J.F. Shigley, Tata McGraw Hill Publication.

3) "Design of Machine Element" M.F.Spotts, Pearson Education Publication, 6th Edition.

4) PSG Design data Book

5) "Mechanical Analysis and Design", H.Burr and Cheatam, Prentice Hall Publication.

6) "Design of Transmission Systems", P. Kannaiah, Scitech Publication.

7) "Machine Design", P. Kannaiah, Scitech Publication, 2nd Edition.

8) "Machine Component Design",Robert C. Juvniall, Willey Ltd, 5th Edition.

9) "Machine Design An Integrated Approach",R.L Norton, Pearson Education Publication, 2nd Edition.

10) "Mechanical Design of Machine Elements and Machines", Jack A Collis Henry Busby,George Staab Wiley

ltd., 2nd Edition.

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

FINITE ELEMENT METHOD

Semester: VI

Course	Code	Credits	Total Hours - 50 Hours /Week		Assessment		Exam Duration in Hrs
			Lecture	Tutorial	SEE	CIE	
Finite Element Method	18ME631	04	03	01	50	50	03

COURSE OBJECTIVES

7. To understand the importance of FEM and its application in solid mechanics.
8. Interpret the various methods in assembling the stiffness equations.
9. To understand and apply Finite element solutions to Structural, dynamic problems.
10. To solve temperature and heat transfer problems.

MODULE-I **(10 hours)**

INTRODUCTION: Introduction to Finite Element Method, Equilibrium equations in elasticity subjected to body force, traction forces, stress-strain relations, Plain stress and Plain strain conditions. Convergence criteria, Discretisation process, types of elements: 1D, 2D and 3D, Node numbering, Location of nodes, half band width. Application and limitations.

MATHEMATICAL PRELIMINARIES: Principle of virtual work, principle of minimum potential energy, Raleigh's Ritz method, Galerkin's method. Direct approach for stiffness matrix formulation of bar element. Numerical problems.

MODULE-II **(10 hours)**

INTERPOLATION MODELS: Interpolation polynomials- Linear, quadratic and cubic. Simplex, complex and multiplex elements. 2D Pascal's triangle. CST elements-Shape functions and Nodal load vector, Strain displacement matrix and Jacobian matrix for triangular and rectangular element.

SOLUTION OF 1-D BARS: Solutions for displacements of 1D Straight bar, stepped bars and tapered bars, reactions and stresses by using penalty approach and elimination approach.

MODULE-III **(12 hours)**

HIGHER ORDER ELEMENTS: Langrange's interpolation, higher order one dimensional elements-Quadratic and cubic element and their shape functions. Shape function of 2-D quadrilateral element-linear, quadric element Isoparametric, Sub parametric and Super parametric elements.
ANALYSIS OF TRUSSES: Stiffness matrix of Truss element. Numerical problems.

MODULE-IV **(08 hours)**

BEAMS: Hermite shape functions for beam element, Derivation of stiffness matrix. Numerical problems of beams carrying concentrated, UDL and linearly varying loads.
TORSION OF SHAFTS: Finite element formulation of shafts, determination of stress and twists in circular shafts.

MODULE-V **(10 hours)**

HEAT TRANSFER: Basic equations of heat transfer: Energy balance equation, Rate equation: conduction, convection, radiation, energy generated in solid, energy stored in solid, 1D finite element formulation using variational method. Problems with temperature gradient and heat fluxes, heat transfer in composite sections, straight fins.

AXISYMMETRIC SOLID ELEMENTS: Derivation of stiffness matrix of axisymmetric bodies with triangular elements, Numerical solution of axisymmetric triangular element(s) subjected to various forces.

COURSE OUTCOMES:

The student will be able to

	Course Outcomes	Course Level
CO1	Analyze the basic procedures involved in finite element method.	U
CO2	Analyze a wide range two-dimensional field problem using finite element techniques and solve 1D bar problems.	Ap
CO3	Use higher order elements in FEM and solve plane truss problems	Ap
CO4	Apply FEM techniques and solve problems involving structures like Beams and Shafts.	Ap
CO5	Apply FEM techniques and solve problems involving heat transfer and axisymmetric solid elements.	Ap
	Total Number of Lecture hours	**50**

TEXT BOOKS:

1. The Finite Element Method in Engineering by Singeresu S Rao, Butterworth-Heinemann, 5th Edition, 2013
2. Finite Element Analysis by Bhavikatti, S S New age International, 3rd Edition 2015
3. Finite Element Method by J N Reddy, TMH.

REFERENCE BOOKS:

1. Introduction to Finite Elements in Engineering by Tirupathi R. Chandrupatla and Ashok D.Belegundu, Pearson Education, 4th Edition 2012.
2. A First Course in the Finite Element Method by Daryl L. Logan, Cengage Learning, 5th Edition 2012.
3. Text book of Finite Element Analysis by Seshu P, Prentice Hall of India
4. Concepts and Applications of Finite Element Analysis by Cook R D, Malkus D S, Plesha ME, John Wiley Sons.
5. Finite Element Methods by R Dhanraj and K Prabhakaran Nair, Oxford University Press.

SCHEME OF EXAMINATION:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

AUTOMATION & ROBOTICS

Semester: VI

Course	Code	Credits	Total Hours - 40 Hours /Week		Assessment		Exam Duration in Hrs
			Lecture	Tutorial	SEE	CIE	
Automation & Robotics	18ME632	04	03	01	50	50	03

Course objectives:

The course aims to,

1] To impart knowledge of Automation and different concepts of automated manufacturing Systems.
2] To understand the concepts of Robotics & its working mechanism
3] Understand the integrated parts of robots and its control systems.
4] Understanding Robot navigation systems, future & its applications
5] To introduce the students to concepts of Artificial Intelligence, Knowing the importance of AI and Integrating AI with robots.

MODULE - 1

Automation: Definition, Reasons for automation, Disadvantages of automation, Automation systems, Types of automation – Fixed, Programmable and Flexible automation, Automation strategies

Automated Manufacturing Systems: Components, classification and overview of manufacturing Systems, Flexible Manufacturing Systems (FMS), Types of FMS, Applications and benefits of FMS.

08 Hours

MODULE - 2

Robotics: Definition of Robot, History of robotics, Robotics market and the future prospects, Applications, Robot Anatomy, Robot configurations: Polar, Cartesian, cylindrical and Jointed-arm configuration.

Robot motions, Joints, Work volume, Robot drive systems, Precision of movement – Spatial resolution, Accuracy, Repeatability, End effectors – Tools and grippers. 08 Hours

MODULE - 3

Controllers and Actuators Basic Control System concepts and Models, Transfer functions, Block diagrams, characteristic equation, Types of Controllers: on-off, Proportional, Integral, Differential, P-I, P-D, P-I-D controllers.

Robot actuation and feedback components: Position sensors – Potentiometers, resolvers, encoders, velocity sensors. Actuators - Pneumatic and Hydraulic Actuators, Electric Motors, Stepper motors, Servomotors, Power Transmission systems.

08 Hours

MODULE - 4

Robot Sensors and Machine vision system: Sensors in Robotics - Tactile sensors, Proximity and Range sensors, use of sensors in robotics.

Machine Vision System: Introduction to Machine vision, the sensing and digitizing function in Machine vision, Image processing and analysis, Training and Vision systems.

08 Hours

MODULE - 5

Robots Technology of the future: Robot Intelligence, Advanced Sensor capabilities, Mechanical design features, Mobility, locomotion and navigation, the universal hand, system integration and networking.

Artificial Intelligence: Introduction, Goals of AI research, AI techniques – Knowledge representation, Problem representation and problem solving, AI and Robotics, LISP in the factory.

08 Hours

Course Outcomes

On completion of the course student will be able to

1. Classify various types of automation &manufacturing systems
2. Discuss different robot configurations, motions, drive systems and its performance parameters.
3. Describe the basic concepts of control systems, feedback components, actuators and power transmission systems used in robots.
4. Explain the working of transducers, sensors and machine vision systems.
5. Discuss the future capabilities of sensors, mobility systems and Artificial Intelligence in the field of robotics.

Text Books

1. Automation, Production Systems and Computer Integrated Manufacturing M.P. Groover, Pearson Education.5th edition, 2009
2. Industrial Robotics, Technology, Programming and Applications by M.P. Groover, Weiss, Nagel, McGraw Hill International, 2nd edition, 2012.

Reference Books

1. Robotics, control vision and intelligence-Fu, Lee and Gonzalez. McGraw Hill International, 2nd edition, 2007.
2. Robotic Engineering - An Integrated approach, Klafter, Chmielewski and Negin, PHI, 1st edition, 2009.
3. “Introduction to Robotics: Mechanics and Control”, Craig, J. J., 2nd Ed., Addison- Wesley Publishing Company, Readong, MA, 1989.

NON-TRADITIONAL MACHINING

Semester: VI

Course	Code	Credits	Total Hours-50 Hours /Week		Assessment		Exam Duration Hours
			Lecture	Tutorial	SEE	CIE	
Non-Traditional Machining	18ME633	03	03	01	50	50	03

Course Objectives Students undergoing this course are expected to:

1. Acquire a functional understanding of non-traditional manufacturing equipment.
2. Understand the terminology used in non-traditional manufacturing industries.
3. To provide knowledge on the classification of non-traditional machining process.
4. Know about various process parameters and their influence on performance and their applications.
5. Impart knowledge on various energy involved in non-traditional machining process.

Module-1

Introduction: History, Classification, comparison between conventional and non-conventional machining process selection. **Ultrasonic Machining (Usm):** Introduction, equipment, tool materials & tool size, abrasive slurry, cutting tool system design: - Effect of parameter: Effect of amplitude and frequency and vibration, Effect of abrasive grain diameter, effect of applied static load, effect of slurry, tool & work material, USM process characteristics: Material removal rate, tool wear, Accuracy, surface finish, applications, advantages & Disadvantages of USM.

Module-2

Abrasive Jet Machining (Ajm): Introduction, Equipment, Variables in AJM: Carrier Gas, Type of abrasive, size of abrasive grain, velocity of the abrasive jet, mean number. abrasive particles per unit volume of the carrier gas, work material, stand off distance (SOD), nozzle design, shape of cut. Process characteristics-Material removal rate, Nozzle wear, Accuracy & surface finish. Applications, advantages & Disadvantages of AJM. Water Jet Machining**:** Principal, Equipment, Operation, Application, Advantages and limitations of water Jet machinery

Electrochemical Machining (Ecm): Introduction, study of ECM machine, elements of ECM process : Cathode tool, Anode work piece, source of DC power, Electrolyte, chemistry of the process, ECM Process characteristics – Material removal rate, Accuracy, surface finish, ECM Tooling: ECM tooling technique & example, Tool & insulation materials, Tool size Electrolyte flow arrangement, Handling of slug, Economics of ECM, Applications such as Electrochemical turning, Electrochemical Grinding, Electrochemical Honing, deburring, Advantages, Limitations.

Module-3

Chemical Machining (Chm): Introduction, elements of process, chemical blanking process: Preparation of work piece, preparation of masters, masking with photo resists, etching for blanking, accuracy of chemical blanking, applications of chemical blanking, chemical milling (contour machining): process steps –masking, Etching, process characteristics of CHM: material removal rate, accuracy, surface finish, Hydrogen embrittlement, advantages & application of CHM.

Electrical Discharge Machining (Edm): Introduction, mechanism of metal removal, dielectric fluid, spark generator, EDM tools (electrodes) Electrode feed control, Electrode manufacture, Electrode wear, EDM tool design, choice of machining operation, electrode material selection, under sizing and length of electrode, machining time. Flushing; pressure flushing, suction flushing, side flushing, pulsed flushing

synchronized with electrode movement, EDM process characteristics: metal removal rate, accuracy, surface finish, Heat Affected Zone. Machine tool selection, Application, EDM accessories / applications, electrical discharge grinding, Traveling wire EDM.

Module-4

Plasma Arc Machining (Pam): Introduction, equipment, non-thermal generation of plasma, selection of gas, Mechanism of metal removal, PAM parameters, process characteristics. Safety precautions, Applications, Advantages and limitations.

Laser Beam Machining (Lbm): Introduction, equipment of LBM mechanism of metal removal, LBM parameters, Process characteristics, Applications, Advantages & limitations. **Electron Beam Machining (EBM):** Principles, equipment, operations, applications, advantages and limitation of EBM.

Module-5

Non-Destructive Testing

NDT Versus Mechanical testing, Overview of the Non-Destructive Testing Methods for the detection of manufacturing defects as well as material characterization. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT., Visual inspection – Unaided and aided.

Liquid Penetrant Testing – Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials Magnetization methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism

TEXT BOOKS:

1. **Modern machining process,** Pandey and Shan, Tata McGraw Hill 2000

2. **New Technology,** Bhattacharya 2000

REFERENCE BOOKS:

1. **Production Technology,** HMT Tata McGraw Hill. 2001

CO1 Understand the need of Non-Traditional Machining Processes and able to Classify various processes.

CO2 recognize the role of mechanical energy in non-traditional machining processes.

CO3 Apply the knowledge on machining electrically conductive material through electrical energy in non-traditional machining processes.

CO4 Understand the concept of machining the hard material using chemical energy and electrochemical energy.

CO5 Familiarity with various thermal energy based nontraditional machining processes.

ADDITIVE MANUFACTURING

Semester: VI

Course	Code	Credits	Total Hours - 40		Assessment		Exam Duration in Hrs
			Hours /Week				
			Lecture	Tutorial	SEE	CIE	
Additive Manufacturing	18ME634	03	03		50	50	03

Module 1

Introduction to Additive Manufacturing: Introduction to AM, AM evolution, Distinction between AM & CNC machining, Advantages of AM, **AM process chain:** Conceptualization, CAD, conversion to STL, Transfer to AM, STL file manipulation, Machine setup, build, removal and clean up, post processing. **Classification of AM processes:** Liquid polymer system, Discrete particle system, Molten material systems and Solid sheet system. **Post processing of AM parts:** Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques.

Guidelines for process selection: Introduction, selection methods for a part, challenges of selection

AM Applications: Functional models, Pattern for investment and vacuum casting, medical models, art models, Engineering analysis models, Rapid tooling, new materials development, Bi-metallic parts, Re-manufacturing. Application examples for Aerospace, defence, automobile, Bio-medical and general engineering industries

Module 2

System Drives and devices: Hydraulic and pneumatic motors and their features, Electrical motors AC/DC and their features **Actuators:** Electrical Actuators; Solenoids, Relays, Diodes, Thyristors, Triacs, Hydraulic and Pneumatic actuators, Design of Hydraulic and Pneumatic circuits, Piezoelectric actuators, Shape memory alloys.

Module 3

POLYMERS & POWDER METALLURGY

Basic Concepts: Introduction to Polymers used for additive manufacturing: polyamide, PF resin, polyesters etc. Classification of polymers, Concept of functionality, Polydispersity and Molecular weight [MW], Molecular Weight Distribution [MWD] **Polymer Processing:** Methods of spinning for additive manufacturing: Wet spinning, Dry spinning. Biopolymers, Compatibility issues with polymers. Moulding and casting of polymers, Polymer processing techniques **General Concepts:** Introduction and History of Powder Metallurgy (PM), Present and Future Trends of PM **Powder Production Techniques:** Different Mechanical and Chemical methods, Atomization of Powder, other emerging processes. **Characterization Techniques**: Particle Size & Shape Distribution, Electron Microscopy of Powder, Interparticle Friction, Compression ability, Powder Structure, Chemical Characterization.

Microstructure Control in Powder: Importance of Microstructure Study, Microstructures of Powder by Different techniques

Powder Shaping: Particle Packing Modifications, Lubricants & Binders, Powder Compaction & Process Variables, Pressure & Density Distribution during Compaction, Isotactic Pressing, Injection Moulding, Powder Extrusion, Slip Casting, Tape Casting.

Sintering: Theory of Sintering, Sintering of Single & Mixed Phase Powder, Liquid Phase Sintering Modern Sintering Techniques, Physical & Mechanical Properties Evaluation, Structure-Property Correlation Study, Modern Sintering techniques, Defects Analysis of Sintered Components

Application of Powder Metallurgy: Filters, Tungsten Filaments, Self-Lubricating Bearings, Porous Materials, Biomaterials etc.

Module 4

NANO MATERIALS & CHARACTERIZATION TECHNIQUES:

Introduction: Importance of Nano-technology, Emergence of Nanotechnology, Bottomup and Top-down approaches, challenges in Nanotechnology **Nano-materials Synthesis and Processing:** Methods for creating Nanostructures; Processes for producing ultrafine powders- Mechanical grinding; Wet Chemical
Synthesis of Nano-materials- sol-gel process; Gas Phase synthesis of Nano-materials- Furnace, Flame assisted ultrasonic spray pyrolysis; Gas Condensation Processing (GPC), Chemical Vapour Condensation(CVC).
Optical Microscopy - principles, Imaging Modes, Applications, Limitations. **Scanning Electron Microscopy (SEM) -** principles, Imaging Modes, Applications, Limitations. **Transmission Electron Microscopy (TEM) -** principles, Imaging Modes, Applications, Limitations.**X- Ray Diffraction (XRD) -** principles, Imaging Modes, Applications, Limitations.**Scanning Probe Microscopy (SPM) -** principles, Imaging Modes, Applications, Limitations.**Atomic Force Microscopy (AFM)** - basic principles, instrumentation, operational modes, Applications, Limitations. **Electron Probe Micro Analyzer (EPMA) -** Introduction, Sample preparation, Working procedure, Applications, Limitations.

Module 5
MANUFACTURING CONTROL AND AUTOMATION
CNC technology - An overview: Introduction to NC/CNC/DNC machine tools, Classification of NC /CNC machine tools, Advantage, disadvantages of NC /CNC machine tools, Application of NC/CNC
Part programming: CNC programming and introduction, Manual part programming: Basic (Drilling, milling, turning etc.), Special part programming, Advanced part programming, Computer aided part programming (APT)
Introduction: Automation in production system principles and strategies of automation, basic Elements of an automated system. Advanced Automation functions. Levels of Automations, introduction to automation productivity **Control Technologies in Automation:** Industrial control system. Process industry vs discrete manufacturing industries. Continuous vs discrete control. Continuous process and its forms. Other control system components.
Course Outcomes
1. Understand the different process of Additive Manufacturing. using Polymer, Powder and Nano materials manufacturing.
2. Analyse the different characterization techniques.
3. Describe the various NC, CNC machine programing and Automation techniques.

TEXT BOOKS:
1. Chua Chee Kai, Leong Kah Fai, “Rapid Prototyping: Principles & Applications”, World Scientific, 2003.
2. G Odian Principles of Polymerization, Wiley Inerscience John Wiley and Sons, 4th edition, 2005
3. Mark James Jackson, Microfabrication and Nanomanufacturing, CRC Press, 2005.
4. Powder Metallurgy Technology, Cambridge International Science Publishing, 2002.
5. P. C. Angelo and R. Subramanian: Powder Metallurgy- Science, Technology and Applications, PHI, New Delhi, 2008.
6. Mikell P Groover, Automation, Production Systems and Computer Integrated Manufacturing, 3rd Edition, Prentice Hall Inc., New Delhi, 2007.

REFERENCE BOOKS:
1. Wohler's Report 2000 - Terry Wohlers - Wohler's Association -2000
2. Computer Aided Manufacturing - P.N. Rao, N.K. Tewari and T.K. Kundra Tata McGraw Hill 1999
3. Ray F. Egerton , Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM , Springer, 2005.
4. P. C. Angelo and R. Subramanian: Powder Metallurgy- Science, Technology and Applications, PHI, New Delhi, 2008.

COMPUTER INTEGRATED MANUFACTURING

Semester: VI

Course	Code	Credits	Total Hours - 40 Hours /Week		Assessment		Exam Duration in Hrs
			Lecture	Tutorial	SEE	CIE	
Computer Integrated Manufacturing	18ME641	04	03	01	50	50	03

COURSE OBJECTIVES

1] To impart knowledge of CIM and Automation and different concepts of automation by developing mathematical models.

2] To make students to understand the Computer Applications in Design and Manufacturing [CAD / CAM) leading to Computer integrated systems. Enable them to perform various transformations of entities on display devices.

3] To expose students to automated flow lines, assembly lines, Line Balancing Techniques, and Flexible Manufacturing Systems.

4] To expose students to computer aided process planning, material requirement planning, capacity planning etc.

5] To expose the students to CNC Machine Tools, CNC part programming, and industrial robots.

6] To introduce the students to concepts of Additive Manufacturing, Internet of Things, and Industry 4.0 leading to Smart Factory.

MODULE - 1

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.

5 Hours

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. 5 Hours

MODULE – 2

3. CAD and Computer Graphics Software: The design process, applications of computers in design, software configuration, functions of graphics package, constructing the geometry. Transformations: 2D transformations, translation, rotation and scaling, homogeneous transformation matrix, concatenation, numerical problems on transformations.

5 Hours

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. 5 Hours

MODULE - 3

5. 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. 5 Hours

6. Line Balancing:

Line balancing algorithms, methods of line balancing, numerical problems on largest candidate rule, Kilbridge and Wester method, and Ranked Positional Weights method, Mixed Model line balancing, computerized line balancing methods. 5 Hours

MODULE - 4.

7. Computer Numerical Control:

Introduction, components of CNC, CNC programming, manual part programming, G Codes, M Codes, programming of simple components in turning, drilling and milling systems, Cutter radius compensations. 5 Hours

8. Robot Technology:

Robot anatomy, joints and links, common robot configurations, robot control systems, accuracy and repeatability, end effectors, sensors in robotics. Robot programming methods: on-line and off-line methods. Robot industrial applications: material handling, processing and assembly and inspection. 5 Hours

MODULE – 5

9. 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. 5 Hours

10. 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.

5 Hours

Course Outcomes:

After studying this course, students will be able to:

CO1 Able to define Automation, CIM, CAD, CAM and explain the differences between these concepts. Solve simple problems of transformations of entities on computer screen.

CO2 Explain the basics of automated manufacturing industries through mathematical models

CO3 Analyze the automated flow lines to reduce down time and enhance productivity.

CO4 Explain the use of different computer applications in manufacturing, and able to prepare part programs for simple jobs on CNC machine tools and robot programming.

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.

Text Books:

1. Automation, Production Systems and Computer-Integrated Manufacturing, by Mikell P Groover, 4th Edition, 2015, Pearson Learning.

2. CAD / CAM Principles and Applications by P N Rao, 3rd Edition, 2015, Tata McGraw-Hill.

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, Apress, 2017, by Alasdair Gilchrist

FINANCIAL MANAGEMENT

Semester: VI

Course	Code	Credits	Total Hours - 40 Hours /Week		Assessment		Exam Duration in hours
			Lecture	Tutorial	SEE	CIE	
Financial Management	18ME642	03	04	00	50	50	03

COURSE OBJECTIVES

1. To familiarize the students with basic concepts of financial management and financial system.
2. To understand concept of time value of money and its uses.
3. To evaluate the investment proposals.
4. To analyze capital structure and dividend decision.
5. To understand the management of working capital in an organization.

MODULE-1 (08 HOURS)

INTRODUCTION TO FINANCIAL MANAGEMENT

Financial management – Introduction to financial management, objectives of financial management. Changing role of finance managers. Interface of Financial Management with other functional areas.

Emerging Issues in financial management: Risk management, Behavioral finance and financial engineering. Introduction to Financial System. Financial markets, Financial Instruments, Financial institutions and financial services. Introduction to derivatives.

MODULE-2 (08 HOURS)

TIME VALUE OF MONEY

Time value of money –Future value of single cash flow & annuity, present value of single cash flow, annuity & perpetuity. Simple interest & Compound interest, Capital recovery & loan amortization. (Theory & Problem). Case Study on Loan amortization

MODULE – 3 (08 HOURS)

SOURCES OF FINANCING & COST OF CAPITAL

SOURCES OF FINANCING: Shares, Debentures, Term loans, Lease financing, Hybrid financing, Venture Capital, Angel investing and private equity, Warrants and convertibles (Theory Only).

COST OF CAPITAL: Basic concepts. Cost of debenture capital, cost of preferential capital, cost of term loans, cost of equity capital (Dividend discounting and CAPM model) - Cost of retained earnings Determination of Weighted average cost of capital (WACC) and Marginal cost of capital. (Theory & Problem). Case Study on WACC.

MODULE – 4 (08 HOURS)

INVESTMENT DECISIONS

Investment decisions – Capital budgeting process, Investment evaluation techniques – Net present value, Internal rate of return, Modified internal rate of return, Profitability index, Payback period, discounted payback period, accounting rate of return (Theory & Problem). Capital rationing; Risk analysis in capital budgeting (Theory only). Case Study on replacement of capital project.

MODULE – 5 (08 HOURS)

WORKING CAPITAL MANAGEMENT

Working capital management – factors influencing working capital requirements - Current asset policy and current asset finance policy Determination of operating cycle and cash cycle - Estimation of working capital requirements of a firm. (Does not include Cash, Inventory & Receivables Management). Case study on Working Capital Determination

COURSE OUTCOMES:

The student will be able to

	Course Outcomes	Course Level
CO1	Understand the basic financial concepts	U
CO2	Apply time value of money.	Ap
CO3	Evaluate the investment decisions	Ap
CO4	Analyze the capital structure and dividend decisions.	Ap
CO5	Estimate working capital requirements.	Ap

U*=Understanding Ap*=Application

TEXT BOOKS:

1. Financial Management -Prasanna Chandra, 9/e, TMH.
2. Financial Management,Khan M.Y.& Jain P. K, 7/e, TMH
3. Financial Management ,I M Pandey, 11th Edition, Vikas Publishing House.

REFERENCE BOOKS:

1. Principles of corporate finance, Brealey and Myers, 9/e,TMH.
2. Financial Management, Rathod, Babitha Thimmaiah,Harish Babu, HPH.
3. Fundamentals of Financial Management, Brigham & Houston, Cengage Learning.

SCHEME OF EXAMINATION:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

TOTAL QUALITY MANAGEMENT

Semester: VI

Course	Code	Credits	Total Hours - 40 Hours /Week		Assessment		Exam Duration in Hrs
			Lecture	Tutorial	SEE	CIE	
TOTAL QUALITY MANAGEMENT	18ME643	03	03	00	50	50	03

Course Learning Objectives:

- Understand various approaches to TQM
- Understand the characteristics of quality leader and his role.
- Develop feedback and suggestion systems for quality management.
- Enhance the knowledge in Tools and Techniques of quality management.

MODULE-1 8 Hours

Principles and Practice: Definition, basic approach, gurus of TQM, TQM Framework, awareness, defining quality, benefits of TQM. Quality Management Systems: Introduction,

Benefits of ISO registration, ISO 9000 series of standards, ISO 9001 requirements.

Environmental Management Systems (EMS): Definition, Basic EMS, EMS under ISO 14001, Costs and Benefits of EMS..

MODULE-2 8 Hours

Customer Satisfaction and Customer Involvement: Customer Satisfaction: customer and customer perception of quality and feedback.

MODULE-3 8 Hours

Continuous Process Improvement: process, the Juran trilogy, quality circle, improvement strategies, types of problems, the PDSA Cycle, problem-solving methods, Kaizen, reengineering, six sigma, case studies.

MODULE-4 8 Hours

Statistical Process Control: Pareto diagram, process flow diagram, cause and effect diagram, check sheets, histograms, statistical fundamentals, Control charts, state of control, out of control process, control charts for variables, control charts for attributes, scatter diagrams, case studies.

MODULE-5 8 Hours

Total Productive Maintenance (TPM): Definition, Types of Maintenance, Steps in introduction of TPM in an organization, Pillars of TPM – 5S, Jishu Hozen, Quality Maintenance, Planned Maintenance.

Quality by Design (QbD): Definition, Key components of QbD, Role of QbD in Pharmaceutical Industry,

Benefits and Challenges of QbD.

COURSE OUTCOMES:

The student will be able to

	Course Outcomes	Course Level
CO1	Explain the various approaches of TQM.	U
CO2	Infer the customer perception of quality.	AP
CO3	Analyze customer needs and perceptions to design feedback systems.	AP
CO4	Apply statistical tools for continuous improvement of systems.	AP
CO5	Apply the tools and technique for effective implementation of TQM.	AP

Text Books:

1. Total Quality Management: Dale H. Bester field, Publisher -Pearson Education India, Edition 07.
2. Total quality management: Author H D RAMCAHNDRA, VIKRAM SINH PACHPUTE, Edition 2014-15

Reference Books:

1. Managing for Quality and Performance Excellence by James R.Evans and Williuam M Lindsay,9th edition, Publisher Cengage Learning.
2. A New American TQM, four revolutions in management, ShojiShiba, Alan Graham, David Walden, Productivity press, Oregon, 1990
3. Organizational Excellence through TQM, H. Lal, New age Publications, 2008.

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

HUMAN RESOURCE MANAGEMENT

Semester: VI **Year: 2020-21**

Course	Code	Credits	Total Hours - 40 Hours /Week		Assessment		Exam Duration in hours
			Lecture	Tutorial	SEE	CIE	
Human Resource Management	18ME644	03	04	00	50	50	03

COURSE OBJECTIVES

1. To understand the HRM concepts and theory.
2. To obtain an overview of various HRM functions and practices.
3. To gain an insight into the basic statutory provisions.

MODULE-1 (08 HOURS)

INTRODUCTION TO HUMAN RESOURCE MANAGEMENT

Introduction, meaning, nature, scope of HRM - Importance and Evolution of the concept of HRM - Major functions of HRM - Principles of HRM

Human Resource Planning: Objectives, Importance and process of Human Resource Planning, Effective HRP.

MODULE-2 (08 HOURS)

JOB ANALYSIS & RECRUITMENT

JOB ANALYSIS: Meaning, process of Job Analysis, methods of collecting job analysis data, Job Description and Job Specification, Role Analysis.

RECRUITMENT: Definition, Constraints and Challenges, Sources and Methods of Recruitment, New Approaches to recruitment.

MODULE – 3 (08 HOURS)

SELECTION & PLACEMENT, TRAINING AND DEVELOPMENT

SELECTION: Definition and Process of Selection.

PLACEMENT: Meaning, Induction/Orientation, Internal Mobility, Transfer, Promotion, Demotion and Employee Separation.

TRAINING AND DEVELOPMENT: Training v/s development, Training v/s Education, Systematic Approach to Training, Training Methods.

MODULE – 4 (08 HOURS)

PERFORMANCE APPRAISAL & COMPENSATION

PERFORMANCE APPRAISAL: Concept of Performance Appraisal, the Performance Appraisal Process, Methods of Performance Appraisal.

COMPENSATION: Objectives of Compensation Planning, Job Evaluation, Compensation Pay Structure in India.

MODULE – 5 (08 HOURS)

EMPLOYEE WELFARE, EMPLOYEE GRIEVANCES & DISCIPLINE:

EMPLOYEE WELFARE: Introduction, Types of Welfare Facilities and Statutory Provisions.

EMPLOYEE GRIEVANCES: Employee Grievance procedure, Grievances Management in Indian Industry.

DISCIPLINE: Meaning, approaches to discipline, essential of a good disciplinary system, managing difficult employees

COURSE OUTCOMES:

The student will be able to

	Course Outcomes	Course Level
CO1	Understanding of HRM functions, principles, Job analysis that facilitates students to design a job description and job specification for various levels of employees	U
CO2	Synthesize knowledge on effectiveness of recruitment process, sources & understanding of systematic selection procedure.	Ap
CO3	Identify the various training methods and design a training program	Ap
CO4	Understand the concept of performance appraisal process in an organization.	Ap
CO5	List out the regulations governing employee benefit practices.	Ap

U*=Understanding Ap*=Application

TEXT BOOKS:

19. Human Resources Management: A South Asian Perspective, Denski/Griffin/Sarkar- Cengage Learning, 2012.
20. Human Resource Management – Rao V. S. P, Excel BOOKS, 2010 “Manufacturing process-2”, Kestoor Praveen, Suggi publishing,5th edition 2013.
21. Human Resource Management – Dr. T.PRenukaMurthy HPH.

REFERENCE BOOKS:

1. Human Resource Management - John M. Ivancevich, 10/e, McGraw Hill.
2. Human Resource Management in practice - Srinivas R. Kandula, PHI, 2009
3. Managing Human Resources - Luis R Gomez-Mejia, David B. Balkin, Robert L. Cardy,6/e, PHI, 2010

SCHEME OF EXAMINATION:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

ENERGY CONVERSION LAB

Semester: VI

Course	Code	Credits	Total Hours - 40 Hours /Week Practical	Assessment		Exam Duration in Hrs
				SEE	CIE	
EC LAB	18MEL65	01	03 (1 Hour Instruction+ 2 Hours Laboratory)	50	50	03

COURSE OBJECTIVES

1. This course will provide a basic understanding of fuel properties and its measurements using various types of measuring devices
2. Energy conversion principles, analysis and understanding of I C Engines will be discussed. Application of these concepts for these
3. machines will be demonstrated. Performance analysis will be carried out using characteristic curves.
4. Exhaust emissions of I C Engines will be measured and compared with the standards.

PART – A

1. Lab layout, calibration of instruments and standards to be discussed
2. Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Marten's (closed) / Cleveland's (Open Cup) Apparatus.
3. Determination of Calorific value of solid, liquid and gaseous fuels.
4. Determination of Viscosity of a lubricating oil using Redwoods, Sayboltand Torsion Viscometers.
5. Analysis of moisture, volatile matter, ash content and fixed carbon of solid and liquid fuel samples
6. Valve Timing/port opening diagram of an I.C. Engine

PART – B

1. Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal efficiency, Volumetric efficiency, Mechanical efficiency, SFC, FP, A:F Ratio, heat balance sheet for
   a. Four stroke Diesel Engine
   b. Four stroke Petrol Engine
   c. Multi Cylinder Diesel/Petrol Engine, (Morse test)
   d. Two stroke Petrol Engine
   e. Variable Compression Ratio I.C. Engine.
2. Measurements of Exhaust Emissions of Petrol engine.
3. Measurements of Exhaust Emissions of Diesel engine
4. Demonstration of pθ , pV plots usingComputerized IC engine test rig

COURSE OUTCOMES:

1. Perform experiments to determine the properties of fuels and oils.
2. Conduct experiments on engines and draw characteristics.
3. Test basic performance parameters of I.C. Engine and implement the knowledge in industry.
4. Identify exhaust emission, factors affecting them and report the remedies.
5. Determine the energy flow pattern through the I C Engine
6. Exhibit his competency towards preventive maintenance of IC engines.

REFERENCE BOOKS:

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

SCHEME FOR EXAMINATION:

Scheme of Examination:
ONE question from part -A: 50 Marks
ONE question from part -B: 30 Marks
Viva –Voice : 20 Marks
Total: 100 Marks

MODELING AND ANALYSIS LAB (FEA)

Semester: VI

Course	Code	Credits	Total Hours - 40 Hours /Week Practical	Assessment		Exam Duration in hrs
				SEE	CIE	
FEA LAB	18MEL66	01	03 (1 Hour Instruction+ 2 Hours Laboratory)	50	50	03

COURSE OBJECTIVES

1. To acquire basic understanding of Modeling and Analysis software
2. To understand the different kinds of analysis and apply the basic principles to find out the stress and other related parameters of bars, beams loaded with loading conditions.
3. To lean to apply the basic principles to carry out dynamic analysis to know the natural frequency of different kind of beams.

PART – A

1. Bars of constant cross section area, tapered cross section area and stepped bar
2. Trusses – (Minimum 2 exercises of different types)
3. Beams – Simply supported, cantilever, beams with point load, UDL, beams with varying load etc(Minimum 6 exercises different nature)

PART – B

1) Thermal Analysis (Minimum 4 exercises of different types)
2) Dynamic Analysis to find
   a) Fixed – fixed beam for natural frequency determination
   b) Bar subjected to forcing function
   c) Fixed – fixed beam subjected to forcing function

3. Stress analysis of a rectangular plate with a circular hole

COURSE OUTCOMES:

1. Demonstrate the basic features of an analysis package.
2. Use the modern tools to formulate the problem, and able to create geometry, descritize, apply boundary condition to solve problems of bars, truss, beams, plate to find stress with differentloading conditions.
3. Demonstrate the deflection of beams subjected to point, uniformly distributed and varying loads further to use the available results to draw shear force and bending moment diagrams.
4. Analyze the given problem by applying basic principle to solve and demonstrate 1D and 2D heat transfer with conduction and convection boundary conditions.
5. Carry out dynamic analysis and finding natural frequencies for various boundary conditions and also analyze with forcing function.

REFERENCE BOOKS:

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

Buchanan, Schaum Series

SCHEME FOR EXAMINATION:
One Question from Part A – 20 Marks (10 Write up +10 Executions)
One Question from Part B - 20 Marks (10 Write up +10 Executions)
Viva-Voce - 10 Marks
Total 50 Marks

CIM LAB

Semester: VI

Course	Code	Credits	Total Hours - 40		Assessment		Exam Duration in hrs
			Hours /Week				
			Lecture	Tutorial	SEE	CIE	
CIM LAB	18MEL67	01	03	01	50	50	03

Course Objectives:

1 To expose the students to the techniques of CNC programming and cutting tool path generation through CNC simulation software by using G-Codes and M-codes.

2 To educate the students on the usage of CAM packages.

3 To make the students understand the importance of automation in industries through exposure to FMS, Robotics, and Hydraulics and Pneumatics.

Part-A

Manual CNC part programming for 2 turning and 2 milling parts. Selection and assignment of tools, correction of syntax and logical errors, and verification of tool path.

CNC part programming using CAM packages. Simulation of Turning, Drilling, Milling operations. 3 typical simulations to be carried out using simulation packages like: **CademCAMLab-Pro, Master-CAM.**

Program generation using software. Optimize spindle power, torque utilization, and cycle time. Generation and printing of shop documents like process and
cycle time sheets, tool list, and tool layouts. Cut the part in single block and auto mode and measure the virtual part on screen.

Post processing of CNC programs for standard CNC control systems like FANUC, SINUMERIC and MISTUBISHI.

Part B

(Only for Demo/Viva voce)

FMS (Flexible Manufacturing System): Programming of Automatic storage and Retrieval system (ASRS) and linear shuttle conveyor Interfacing CNC lathe,
milling with loading unloading arm and ASRS to be carried out on simple components.

(Only for Demo/Viva voce)

Robot programming: Using Teach Pendent & Offline programming to perform pick and place, stacking of objects (2 programs).

Pneumatics and Hydraulics, Electro-Pneumatics: 3 typical experiments on Basics of these topics to be conducted.

Course Outcomes:

After studying this course, students will be able to:

CO 1: Generate CNC Lathe part program for Turning, Facing, Chamfering, Grooving, Step turning, Taper turning, Circular interpolation etc.

CO 2: Generate CNC Mill Part programming for Point to point motions, Line motions, Circular interpolation, Contour motion, Pocket milling- circular, rectangular, Mirror commands etc.

CO 3: Use Canned Cycles for Drilling, Peck drilling, Boring, Tapping, Turning, Facing, Taper turning Thread cutting etc.

CO 4: Simulate Tool Path for different Machining operations of small components using CNC Lathe & CNC Milling Machine.

CO 5: Use high end CAM packages for machining complex parts; use state of art cutting tools and related cutting parameters; optimize cycle time.

CO 6: Understand & write programs for Robot control ; understand the operating principles of hydraulics, pneumatics and electropneumatic systems. Apply this knowledge to automate & improve efficiency of manufacturing.

Scheme for Examination:
Two Questions from Part A - 60 Marks (30 +30)
Viva-Voce - 20 Marks
Total: 80 Marks

MINI PROJECT-VI

Semester: VI

Course	Code	Credits	Total Hours - 24 Hours /Week		Assessment		Exam Duration in Hrs
			Lecture	Practical	SEE	CIE	
Mini project-VI	18MEMP68	01	00	02	50	50	02

OBJECTIVES:

To introduce fundamental concepts and analysis techniques in engineering to students across all disciplines.

Mini-project work:

Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.

CONTROLENGINEERING

Semester: VI

COURSE	CODE	CREDITS	L-T-P	ASSESSMENT		EXAMDURATION
				SEE	CIE	
ME 7thSEM	18ME71	04	4-0-0	50	50	3HOURS

COURSEOBJECTIVES

CO1	To explain the necessity of feedback and types of feedback control systems. Introducetheconceptoftransferfunctionanditsapplicationtothemodelingoflinearsystems
CO2	To demonstrate mathematical modeling of control systems. Transfer function of systems through block diagram manipulation and reduction and use of Mason's gain formula for Finding transfer function of a system
CO3	To discuss the stability of linear time invariant systems and Routh-Hurwitz criterion and investigatethetrajectoriesoftherootsofthecharacteristicequationwhenasystemparameter is varied
CO4	ToanalyzestabilityofacontrolsystemusingNyquistplotanddiscussthestabilityanalysisusingBodeplots.
CO5	To determine the **controller or compensator configuration** and its **parameter values** based on the manner in which it is **connected to the controlled process**, ensuring compliance with the **given design specifications**.

MODULE1	**HOURS**
Introduction: Conceptofautomaticcontrols,Openloopandclosedloopsystems,Conceptsoffeedback,requirements of an ideal control system, Types of controllers- Proportional,Integral,Differential, Proportional &Integral, Proportional Differential and Proportional Integral Differential controllers.	10
MODULE2	
ModelingofPhysicalSystems: MathematicalModelsofMechanical,Electrical,Thermal, Hydraulic and Pneumatic Systems. **Analogous Systems**: Direct and inverse analogs for mechanical, thermal and fluid systems. **Block diagram Algebra:** General representation of a feedback control system,transfer functions, rules of block diagram algebra, reduction of block dia. to obtain closed loop transfer function. **Signalflow graphs:**Mason'sgainformula	10
MODULE 3	
Steady state operation: Steady state analysis for general block dia. for acontrol system, steady state characteristics,equilibrium in a system. **Transient Response:** Transient response and steady state analysis of unit,step input, general operational representation for a differential equation of control system, distinct, repeated and complex conjugate zeros, general form of transient response,Routh's stability criterion for a control system. **Root Locus Plots :** Root locus method: Significance of Root locus, angle and magnitude conditions,breakawaypoints,anglesofdepartureandarrival, constructionofRootlocususinggeneralrulesandsteps.	10

MODULE4	
Frequency Domain Analysis: Relationshipbetweentimeandfrequencyresponse,Polarplot,Bode'sPlot,Nyquistplot and Nyquist stability criterion, Relative Stability, Phase and Gain Margins	10
MODULE5	
System Compensation and State Variable Characteristics of Linear Systems: Series and feedback compensation, Lead, Lag and lead-lag compensation.Introductiontostateconcepts,stateequationoflinearcontinuousdatasystem. Matrix representation of state equations, controllability and observability,KalmanandGilbertstest.	10

Course Outcomes

At the end of the course the student will be able to:

- Discuss the effects of feedback and types of feedbackcontrolsystems.
- Evaluatethetransferfunctionofalineartimeinvariantsystem.
- Evaluate the stability of linear time invariant systems.
- Apply block diagram manipulation and signal flow graph methods to obtain transfer function of systems.
- Demonstratetheknowledgeofmathematicalmodelingofcontrolsystemsandcomponents
- Determinetransientandsteadystatetimeresponseofasimplecontrolsystem.
- Investigatetheperformanceofagivensystemintimeandfrequencydomains.
- Discuss stability analysis using Rootlocus,BodeplotsandNyquistplots.
- Determine the controller or compensator configuration and parameter values relative tohowitisconnectedtothe controlledprocess given thedesignspecifications.

	TEXTBOOKS
1	"Control Engineering"UABakshi, Technical Publication2nd Edition,2015
2	"Control Engineering"by Halesh,Publishedby SapanBook House,2nd Edition, Jan2015
	REFERENCEBOOKS
	Control system engineering, NormanSNise,JohnWiley&Sons,Inc.,Sixthedition
	4.Modern control systems,RichardC.Dorf,RobertHBishop,PearsonEducation International,Twelfthedition.
	5.Automatic control systems,FaridGolnaraghi,BenjaminCKuo,JohnWiley& Sons,Inc.,Ninethedition
	6.J.NagrathandM.Gopal,"ControlSystemEngineering",NewAgeInternational Publishers,5thEdition,2007
	7."Feedbackcontrolsystems",Schaum'sseries,2001.
	8.Systemdynamics and control,Eronini-Umez,ThomasAsiaPteltd.,Singapore2002

OPERATIONS RESEARCH

Semester: VII

Course	Code	Credits	Total Hours - 50 Hours /Week		Assessment		Exam Duration in Hrs
			Lecture	Tutorial	SEE	CIE	
Operations Research	18ME721	03	03	01	50	50	03

COURSE OBJECTIVES

1. To enable the students to understand and analyze managerial problems in industry the so that they are able to use limited resources in the form of Men, Materials and machinery more efficiently.
2. To apply various optimization techniques for decision making
3. To develop knowledge of formulating mathematical models for quantitative analysis of managerial problems in industry.

Module-1 Introduction of Operations research and Linear programming problem (10 hours)

Introduction: Evolution of OR, Definitions of OR, Scope of OR, Applications of OR, Phases in OR study. Characteristics and limitations of OR, models used in OR.

Linear Programming Problem (LPP): Generalized LPP- Formulation of problems as L.P.P. Solutions to LPP by graphical method (Two Variables).

Module-2 Solution of LPP by Simplex method and Concept of duality (10 hours)

LPP by Simplex method: Canonical and Standard form of LP problem, slack, surplus and artificial variables, Solutions to LPP by Simplex method, Big-M Method and Two-Phase Simplex Method, Degeneracy in LPP.

Concept of Duality: writing Dual of given LPP. Solutions to L.P.P by Dual Simplex Method

Module-3 Transportation and Assignment Problem (10 hours)

Transportation Problem: Formulation of transportation problem, types, initial basic feasible solution using North-West Corner rule, Vogel's Approximation method. Optimality in Transportation problem by Modified Distribution (MODI) method. Unbalanced T.P. Maximization T.P. Degeneracy in transportation problems, application of transportation problem.

Assignment Problem: Formulation, Solutions to assignment problems by Hungarian method, Special cases in assignment problems, unbalanced, Maximization assignment problems.

Travelling Salesman Problem (TSP). Difference between assignment and T.S.P, Finding best route by Little's method. Numerical Problems.

Module-4 Game Theory and Sequencing (10 hours)

Game Theory: Definition, Pure Strategy problems, Saddle point, Max-Min and Min-Max criteria, Principle of Dominance, Solution of games with Saddle point. Mixed Strategy problems. Solution of 2X2 games by Arithmetic method, Solution of 2Xn m and mX2 games by graphical method. Formulation of games.

Sequencing: Basic assumptions, Johnson's algorithm, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines. Sequencing of2 jobs on 'm' machines using graphical method

Module-5 Network analysis and Queuing Theory (10 hours)

Network analysis: Introduction, Construction of networks, Fulkerson's rule for numbering the nodes, AON and AOA diagrams; Critical path method to find the expected completion time of a project, determination of floats in networks, PERT networks, determining the probability of completing a project, predicting the completion time of project; Cost analysis in networks. Crashing of networks- Problems.

Queuing Theory: Queuing systems and their characteristics, Pure-birth and Pure-death models (only equations), Kendall & Lee's notation of Queuing, empirical queuing models – Numerical on M/M/1 and M/M/C Queuing models

COURSE OUTCOMES: The student will be able to

	Course Outcomes	**Course Level**
CO1	Understand the meaning, definitions, scope, need, phases and techniques of operations research.	Understand
CO2	Define and formulate as L.P.P and derive optimal solutions to linear programming problems by graphical method, Simplex method, Big-M method and Dual simplex method.	Understand and Application
CO3	Formulate as Transportation and Assignment problems and derive optimum solutions for transportation, Assignment and travelling salesman problem	Understand, application and analysis
CO4	Solve problems on game theory for pure and mixed strategy under competitive environment. Determine minimum processing times for sequencing of n jobs-2 machines, n jobs-3machines,n jobs-m machines and 2 jobs-n machines using Johnson's algorithm	Application
CO5	Construct network diagrams and determine critical path, floats for deterministic and PERT networks including crashing of Networks. Solve waiting line problems for M/M/1 and M/M/K queuing mode	Application and Analysis
	Total Number Lecture hours	**50**

TEXT BOOKS:

4. Operations Research, P K Gupta and D S Hira,S. Chand and Company LTD. Publications, New Delhi – 2

5. Operations Research, Theory and Applications, Sixth Edition, J K Sharma, Trinity Press, Laxmi Publication.

6. Operations Research, An Introduction, Seventh Edition, Hamdy A. Taha, PHI Private Limited, 2006.

REFERENCE BOOKS:

7. Operations Research, A M Natarajan, P Balasubramani, Pearson Education, 2005
8. Operations Research, Hillier and Lieberman,8th Ed., McGraw Hill
9. Operations Research, 4th edition, Kalavathy S, Vikas Publishing House PVT.LTD – New Delhi.
10. Operation Research, P Shankara Iyer, Mc graw Hill Higher Education, 2008. New Delhi.
11. Operations Research an Introduction., P Mariappan. Pearson Education India., 1971

SCHEME OF EXAMINATION:

Two questions to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

HEAT AND MASS TRANSFER

Semester: VII

Course	Code	Credits	Total Hours - 40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
HMT	18ME731	**03**	**03**	**00**	**50**	**50**	**03**

Course Objectives:

Course Learning Objectives: Study the modes of heat transfer.• Learn how to formulate and solve 1-D steady and unsteady heat conduction problems.• Apply empirical correlations for fully-developed laminar, turbulent internal flows and external• boundary layer convective flow problems. Study the basic principles of heat exchanger analysis and thermal design.• Understand the principles of boiling and condensation including radiation heat transfer related• engineering problems.

MODULE -I Introductory Concepts and Definitions 10 hours

Modes of heat transfer: Basic laws governing conduction, convection, and radiation heat transfer; Thermal conductivity; convective heat transfer coefficient; radiation heat transfer; combined heat transfer mechanism. Boundary conditions of 1st, 2nd and 3rd kind Conduction: Derivation of general three-dimensional conduction equation in Cartesian coordinate, special cases, One dimensional conduction equation in rectangular, cylindrical and spherical coordinates for plane and composite walls. Overall heat transfer coefficient. Thermal contact resistance.

MODULE -II Variable Thermal Conductivity 10 hours

Derivation for heat flow and temperature distribution in plane wall. Critical thickness of insulation without heat generation, Thermal resistance concept & its importance. Heat transfer in extended surfaces of 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. Numerical problems.

MODULE-III Forced Convections 10hours

Applications of dimensional analysis for forced convection. Physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers. Use of various correlations for hydro dynamically and

thermally developed flows inside a duct, use of correlations for flow over a flat plate, over a cylinder and sphere. Numerical problems.

MODULE -IV Heat Exchangers, Condensation and Boiling 10hours

Classification of heat exchangers; overall heat transfer coefficient, fouling and fouling factor; LMTD, Effectiveness-NTU methods of analysis of heat exchangers. Numerical problems. Types of condensation (discussion only) Nusselt's theory for laminar condensation on a vertical flat surface; use of correlations for condensation on vertical flat surfaces, horizontal tube and horizontal tube banks; Reynolds number for condensate flow; regimes of pool boiling, pool boiling correlations.

MODULE -V Radiation Heat Transfer 10 hours

Thermal radiation; definitions of various terms used in radiation heat transfer; Stefan-Boltzman law, Kirchoff's law, Planck's law and Wein's displacement law. Radiation heat exchange between two parallel infinite black surfaces, between two parallel infinite gray surfaces; effect of radiation shield; intensity of radiation and solid angle; Lambert's law; radiation heat exchange between two finite surfaces-configuration factor or view factor. Numerical problems.

Text Books:

1. Principals of heat transfer Frank Kreith, Raj M. Manglik, Mark S. Bohn Cengage learning Seventh Edition 2011.
2 Heat transfer, a practical approach Yunus A. Cengel Tata Mc Graw Hill Fifth edition

Reference Books

1 Heat and mass transfer Kurt C, Rolle Cengage learning second edition
2 Heat Transfer a Basic Approach M. NecatiOzisik McGraw Hill, New York 2005
3 Fundamentals of Heat and Mass Transfer Incropera, F. P. and De Witt, D. P John Wiley and Sons, New York 5th Edition 2006
4 Heat Transfer Holman, J. P. Tata McGraw Hill, New York 9th Edition 20

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions choosing at least one full question from each module.

ENERGY ENGINEERING

Semester: VII

Course	Code	Credits	Total Hours - 40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Tutorial	SEE	CIE	
EE	18ME741	**03**	**03**	**00**	**50**	**50**	**03**

Module-1
Thermal Energy conversion system:

Review of energy scenario in India,General Philosophy and need of Energy,Different Types of Fuels used for steam generation,Equipment for burning coal in lump form, strokers, different types, Oil burners, Advantages and Disadvantages of using pulverized fuel, Equipment for preparation and burning of pulverized coal, unit system and bin system.Pulverized fuel furnaces, cyclone furnace, Coal and ash handling, Generation of steam using forced circulation, high and supercritical pressures. Chimneys: Natural, forced, induced and balanced draft, Accessories for the Steam generators such as Superheaters, De-superheater, control of superheaters, Economizers, Air preheatersand re-heaters. **9 hours**

Module-2
Diesel Engine Power System:

Applications of Diesel Engines in Power field. Method of starting Diesel engines. Auxiliaries like cooling and lubrication system, filters, centrifuges, Oil heaters, intake and exhaust system, Layout of diesel power plant.

Hydro-Electric Energy:

Hydrographs, flow duration and mass curves, unit hydrograph and numerical. Storage and pondage, pumped storage plants, low, medium and high head plants, Penstock, water hammer, surge tanks, gates and valves. General layout of hydel power plants.

Module-3
Solar Energy:
Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces; Measurement of solar radiation data, Solar Thermal systems: Introduction; Basics of thermodynamics and heat transfer; Flat plate collector; Evacuated Tubular Collector; Solar air collector; Solar concentrator; Solar distillation; Solar ponds, Solar dryers, Solar cooker; Solar refrigeration and air conditioning; Thermal energy storage systems, Solar Photovoltaic cells.

Module-4
Wind Energy:

Properties of wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, wind machines; Types of wind machines and their characteristics, horizontal and vertical axis wind mills, coefficient of performance of a wind mill rotor(Numerical Examples).

Tidal Power:

Tidal energy scenario in India. Tides and waves as energy suppliers and their mechanics; fundamental characteristics of tidal power, harnessing tidal energy, limitations.

Module-5
Biomass Energy:
Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies; Urban waste to energy conversion; Biomass gasification.

Green Energy:

Introduction: Fuel cells: Overview; Classification of fuel cells; Operating principles; Fuel cell thermodynamics Nuclear, ocean, MHD, thermoelectric and geothermal energy applications; Origin and their types; Working principles, Zero energy Concepts

Course Outcomes

At the end of the course, the student will be able to:

• Summarize the basic concepts of thermal energy systems,

• Identify renewable energy sources and their utilization.

• Understand the basic concepts of solar radiation and analyse the working of solar PV and thermal systems.

• Understand principles of energy conversion from alternate sources including wind, geothermal, ocean, biomass, biogas.

• Understand the concepts and applications of fuel cells, thermoelectric convertor and MHD generator.

• Identify methods of energy storage for specific applications

TEXT BOOKS:

1. B H Khan, Non-conventional energy resources, 3rd Edition, McGraw Hill Education

2. Principles of Energy conversion, A. W. Culp Jr., McGraw Hill. 1996

REFERENCE BOOKS:

1. S.P. Sukhatme, Solar Energy: principles of Thermal Collection and Storage, Tata McGraw-Hill (1984).

2. C. S. Solanki, “Solar Photovoltaic’s: Fundamental A pplications and Technologies, Prentice Hall of India, 2009.

3. L.L. Freris, Wind Energy Conversion Systems, Prentice Hall, 1990.

Scheme of Examination:

- Two question to be set from each module.
- Students have to answer five full questions, choosing at least one full question from each module.

HEAT AND MASS TRANSFER LAB

Semester: VII

Course	Code	Credits	Total Hours - 40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Practical	SEE	CIE	
HMT LAB	18MEL75	01	00	02	50	50	03

Experiments

PART A

1.Determination of Thermal Conductivity of a Metal Rod.
2.Determination of Overall Heat Transfer Coefficient of a Composite wall.
3.Determination of Effectiveness on a Metallic fin.
4.Determination of Heat Transfer Coefficient in free Convection
5.Determination of Heat Transfer Coefficient in a Forced Convention
6.Determination of Emissivity of a Surface.

PART B

1.Determination of Stefan Boltzmann Constant.
2.Determination of LMDT and Effectiveness in a Parallel Flow and Counter Flow Heat Exchangers.
3.Experiments on Boiling of Liquid and Condensation of Vapour.
4.Performance Test on a Vapour Compression Refrigeration.
5.Performance Test on a Vapour Compression Air – Conditioner.
6.Experiment on Transient Conduction Heat Transfer.

PART C (OPTIONAL)

1. Analysis of steady and transient heat conduction, temperature distribution of plane wall and cylinder using Numerical approach (ANSYS/CFD package).
2. Determination of temperature distribution along a rectangular and circular fin subjected to heat loss through convection using Numerical approach (ANSYS/CFD package).

Course Outcomes:

At the end of the course, the student will be able to:

1. CO1: Determine the thermal conductivity of a metal rod and overall heat transfer coefficient of composite slabs.
2. CO2: Determine convective heat transfer coefficient for free and forced convection and correlate with theoretical values.
3. CO3: Evaluate temperature distribution characteristics of steady and transient heat conduction through solid cylinder experimentally.
4. CO4: Determine surface emissivity of a test plate and Stefan Boltzmann constant
5. CO5: Estimate performance of a refrigerator and effectiveness of a fin and Double pipe heat exchanger

Scheme of Examination:

Perform any two experiments
One Question from Part A – 20 Marks
One Question from Part B – 20 Marks
Viva-Voce – 10 Marks

Course Outcomes

- At the end of the course, the students will be able to:
- Understanding operating principles and constructional features of hydraulic and pneumatic systems.
- Knowledge with selection of hydraulic / pneumatic components
- Understanding of designing and layout of Hydraulic Power package and trouble shooting.

ENERGY ENGINEERING VIRTUAL LAB

Semester: VII

Course	Code	Credits	Total Hours - 40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Practical	SEE	CIE	
EEVL	18MEL77	01	00	02	50	50	03

Wind Energy

Wind is a form of renewable energy which is cheaply available. Wind energy is also a good source of clean and green electricity. The Wind Energy lab imparts with the users an approach to study about the wind characteristics and wind energy harnessing.

Anemometer

Calculating the Average Wind Energy Density (WED) from Actual Wind Data

Wind Modelling Analysis

Learn about the wind distribution pattern of a given location

Wind Tunnel - Pressure

Aerodynamic Pressure distribution study of a Wind Turbine Blade in a Wind Tunnel under constant velocity

Wind Tunnel- Force

Aerodynamic Force Study of a Wind Turbine Blade in a Wind Tunnel with varying velocity

Wind Tunnel - Angle

Aerodynamic force study of a wind turbine blade with varying pitch (Wind tunnel)

Wind Tunnel -Pitot

Velocity profiling of a wind turbine blade and calculation of drag coefficient

Solar energy

Sun is the primary source of energy on the earth. Solar energy is abundant and is directly available and can be harnessed in many ways. This Solar Energy lab equips with the user a chance to study the radiation characteristics of the sun and various methods of solar energy harnessing.

Solar Energy Measurements - Pyrheliometer

Direct Normal Irradiance (DNI) and Concentrating Solar Thermal Site Analysis

Solar Energy Measurements - Pyranometer
Global Horizontal Irradiance (GHI)

Solar Energy Measurements
To study the various solar irradiance measurements using pyrheliometer and pyrano meteters. Comparing the Global horizontal irradiance, Diffuse horizontal irradiance and Direct normal irradiance levels.

Solar PV Tracker
Determining I-V and P-V curves and the Maximum Power Point for a Solar PV Cell under Varying Irradiance

Scheme of Examination:

Perform any two virtual experiments

1. One Question from Part A – 20 Marks
2. One Question from Part B – 20 Marks
3. Viva-Voce – 10 Marks

PROJECT

Semester: VII

Course	Code	Credits	Total Hours - 40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Practical	SEE	CIE	
MP	18MEMP78	01	00	16	50	50	03

Course Objectives

1. To support independent learning.
2. To guide students in selecting and utilizing adequate information from varied resources while maintaining ethics.
3. To help students organize their work appropriately and present information clearly, with proper acknowledgment of sources.
4. To develop interactive, communication, organizational, time management, and presentation skills.
5. To impart flexibility and adaptability.
6. To inspire both independent and team working.
7. To expand intellectual capacity, credibility, judgment, and intuition.
8. To adhere to punctuality, and practice setting and meeting deadlines.
9. To instill a sense of responsibility towards oneself and others.
10. To train students to confidently present their project work in seminars, face the audience without fear, enhance communication skills, and engage in group discussions to exchange ideas.

Project Work Phase - II

Each student in the project batch shall actively engage in carrying out the project work **jointly**, in **constant consultation with the internal guide, co-guide, and external guide**. The **project report** must be prepared according to prescribed norms and should **strictly avoid plagiarism**.

Course Outcomes

By the end of the course, students will be able to:

- Present their project and effectively defend it.
- Make interdisciplinary connections to generate, develop, and evaluate ideas and information for the project.
- Develop critical thinking habits and apply problem-solving skills.
- Communicate effectively and present ideas clearly and coherently in both written and oral forms.
- Work collaboratively in a team to achieve a common goal.
- Learn independently, reflect on their learning, and take appropriate steps to improve it.

Continuous Internal Evaluation (CIE)

Component	Marks	Details
Project Report	15 marks	Based on the student's involvement in the project and the preparation of the report. Marks to be awarded by the internal guide in consultation with external guide, if any.
Project Presentation	25 marks	Evaluated by a departmental committee of three faculty members, with the senior-most acting as Chairperson.
Question & Answer	10 marks	Based on the student's ability to answer questions effectively during the evaluation session.

Semester End Examination (SEE)

Component	Marks	Details
Project Report	20 marks	Evaluated based on report quality.
Seminar Presentation	20 marks	Evaluated based on the quality of delivery and presentation skills.
Question & Answer	10 marks	Evaluated on participation and performance in the Q&A session.

The SEE marks shall be awarded by **examiners appointed by the University** based on the **overall quality** of the project, **presentation skills**, and **participation** during the seminar and Q&A session.

INDUSTRIAL PSYCHOLOGY AND ORGANISATIONAL BEHAVIOUR
B.Tech, VII Semester, Mechanical Engineering
[As per Choice Based Credit System (CBCS) scheme]

Subject Code	18HSM79	CIE Marks	50
Number of Lecture Hour/Week	01	SEE Marks	50
Total Number of Lecture Hours	20	Exam Hours	03

CREDITS-01

Course Objectives: This course will enable students to:

1. Relating human psychology to science
2. Understand the human psychology
3. Understand the nature of organization and organization models
4. Understand the human social communication
5. Understand the leadership qualities

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
Module -1		
Introduction- psychology as a science- area of applications – study of individual- individual differences- study of behaviour- stimulus- response behaviour- heredity and environment	**4 Hours**	**L1,L2**
Module -2		
Human mind- cognition- character- thinking- attention- memory- emotion- traits- attitude- personality	**4 Hours**	**L1,L2**
Module -3		
Organizational behaviour- definition – development- fundamental concept- nature of people nature of organization	**4 Hours**	**L1,L2**
Module -4		
Understanding a social-system social culture- managing communication- downward, upward and other forms of communication	**4 Hours**	**L1, L2,L3**
Module-5		
Motivation- motivation driver- human needs- behaviour modification- goal setting- expectancy model- comparison models.	**4 Hours**	**L1,L2,L3**

Course Outcomes: At the end of this course, students would be able to

1. Comprehend the knowledge and concepts of human psychology
2. know the importance of psychology
3. have insight into individual and group behavior
4. deal with people in better way
5. motivate groups and build groups

Text Books:

"Davis K. & Newstrom J.W., Human Behaviour at work, Mcgraw Hill International, 1985

Reference Books:

1. Blum M.L. Naylor J.C., Horper & Row, Industrial Psychology, CBS Publisher, 1968
2. Luthans, Organizational Behaviour, McGraw Hill, International, 1997
3. Morgan C.t.,King R.A.,John Rweisz &John Schoples, Introduction to Psychology, McHraw Hill, 1966
4. Schermerhorn J.R.Jr., Hunt J.G &Osborn R.N., Managing, Organizational Behaviour, John Willy

INTERNSHIP

Semester: VIII

Course	Code	Credits	Total Hours - 40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Practical	SEE	CIE	
INTERNSHIP	18MEI82	10	-	-	50	50	03

Course Objectives: Internship / Professional Practice

Internship or professional practice offers students hands-on experience in areas such as:

- Personal training
- Time and stress management
- Interactive skills
- Presentations
- Budgeting and marketing
- Liability and risk management
- Paperwork handling
- Equipment ordering and maintenance
- Responding to emergencies

The specific objectives are to:

1. **Put theory into practice.**
2. **Expand thinking and broaden the knowledge and skills acquired through coursework.**
3. **Interact with and learn from current professionals in the field.**
4. **Gain a deeper understanding of the duties and responsibilities of professionals.**
5. **Understand and adhere to professional standards.**
6. **Gain insight into professional communication**, including:
    - Meetings
    - Memos
    - Reading and writing
    - Public speaking
    - Research
    - Client interaction
    - Input of ideas
    - Confidentiality
7. **Identify personal strengths and weaknesses.**
8. **Develop initiative and motivation to become a self-starter and work independently.**

Internship / Professional Practice Guidelines

- Students must regularly participate in all internship activities under the guidance of internal and external guides.
- Students should acquire as much knowledge and practical exposure as possible **without causing any inconvenience** at the internship site.

Seminar Requirements

Each student is required to:

- **Present a seminar** based on their internship experience using oral or PowerPoint formats.
- **Answer questions** and participate in **discussions or debates** during the seminar.
- **Submit a detailed report**, duly certified by the external guide.
- **Engage in peer discussions** to foster a **friendly and intellectually stimulating**

environment, promoting **motivation, self-confidence, and high standards**.

Course Outcomes

By the end of this course, students will be able to:

- Gain **practical experience** in the industry where the internship was completed.
- Acquire **first-hand knowledge of industry operations**.
- Apply learned **knowledge and skills** to academic and professional settings.
- Gain a better understanding of **career options** and define **personal career goals**.
- Experience the **roles and responsibilities** of professionals in the field.
- Develop and refine **oral and written communication skills**.
- Identify **areas for future knowledge and skill development**.
- Expand **intellectual capacity, credibility, judgment, and intuition**.
- Acquire knowledge in **administration, marketing, finance, and economics**.

Continuous Internal Evaluation (CIE)

Total Marks: 50

Component	Marks	Evaluation Criteria
Internship/Professional Practice Report	20 marks	Based on the **quality of the report** and **student's involvement** in preparing it.
Seminar Presentation	20 marks	Assessed based on **presentation skills**, clarity, content delivery, and communication.
Question & Answer Session	10 marks	Evaluated based on **active participation**, ability to answer questions clearly and confidently.

Evaluation Committee:

- Constituted by the **Head of the Department (HoD)**.
- Includes **three faculty members** from the department.
- The **senior-most faculty** acts as the **Chairperson**.

Semester End Examination (SEE)

Total Marks: 50

Component	Marks	Evaluation Criteria
Internship Report	20 marks	Judged on the **depth, quality, and structure** of the report.
Seminar Presentation	20 marks	Evaluated on **presentation quality, professionalism, and communication skills**.
Question & Answer Session	10 marks	Based on **student engagement** and ability to respond effectively during the Q&A.

Evaluators:

- Marks are awarded by **university-appointed examiners** based on overall **report quality**, **presentation skills**, and **Q&A session performance**.

PROJECT-VIII

Semester: VIII

Course	Code	Credits	Total Hours - 40 Hours/Week		Assessment		Exam Duration in Hours
			Lecture	Practical	SEE	CIE	
PROJ	18PRJ81	10	00	02	50	50	03

Course Objectives

- To support independent learning.
- To guide students in selecting and utilizing adequate information from varied resources while maintaining ethical standards.
- To help organize work appropriately and present information clearly, with proper acknowledgment of sources.
- To develop interactive, communication, organizational, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team-based working.
- To expand intellectual capacity, credibility, judgment, and intuition.
- To emphasize punctuality, and the ability to set and meet deadlines.
- To instill responsibility toward oneself and others.
- To train students to confidently present project work in a seminar, face audiences without fear, enhance communication skills, and actively participate in group discussions to exchange ideas.

Project Work Phase – II

Each student in the project batch is required to **collaboratively carry out the project work** in **continuous consultation with the internal guide, co-guide, and external guide**. The **project report must be prepared in accordance with institutional norms**, ensuring **zero plagiarism** and high academic integrity.

Course Outcomes

By the end of the course, students will be able to:

- Present and confidently defend their project.
- Establish links across different areas of knowledge and effectively **generate, develop, and evaluate** ideas and information for the project.
- Develop **critical thinking** and apply **problem-solving** skills.
- Communicate effectively and present ideas clearly and coherently in both written and oral forms.
- Collaborate effectively as part of a team to achieve shared goals.
- Learn independently, reflect on their own learning process, and take appropriate actions to enhance their performance.