|| Jai Sri Gurudev||

ADICHUNCHANAGIRI UNIVERSITY

BGS Institute of Technology

B. E. Mechanical Engineering

Scheme for Third Semester Mechanical Engineering

Sl. No	Course Code	Title of the Course	Teaching Department	Teaching Hours/week				Examination				credits
				L	T	P	TL	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
1	18MAT31	Engineering Mathematics – III	Mathematics	3	0	0	3	3	40	60	100	3
2	18ME32	Strength of Materials	ME	4	1	0	5	3	40	60	100	4
3	18ME33	Basic Thermodynamics	ME	4	1	0	5	3	40	60	100	4
4	18ME34	Manufacturing process-I	ME	3	0	0	3	3	40	60	100	3
	Group-A											
5	18ME35A	Materials Science	ME	3	0	0	3	3	40	60	100	3
6	18ME36A	Computer Aided Machine Drawing	ME	2	0	3	5	3	40	60	100	3
7	18MEL37A	Materials Testing Lab	ME	1	0	2	3	3	40	60	100	2
8	18MEL38A	Foundry and Forging Lab	ME	1	0	2	3	3	40	60	100	2
	Group-B											
5	18ME35B	Mechanical Measurements and Metrology	ME	3	0	0	3	3	40	60	100	3
6	18ME36B	Manufacturing process-II	ME	3	0	0	3	3	40	60	100	3
7	18MEL37B	Mechanical Measurements and Metrology Lab	ME	1	0	2	3	3	40	60	100	2
8	18MEL38B	Machine Shop	ME	1	0	2	3	3	40	60	100	2
9	18SSD 39	Soft Skill Development-1	HRD	2	0	0	2	2	20	30	50	1
10	18KAN30	Kannada Manasu	Humanities	2	--	--	2	2	20	30	50	0
TOTAL CREDITS & CONTACT HOURS							**32**		**360**	**540**	**900**	**25**
TOTAL CREDITS OF I SEMESTER TO III SEMESTER				(I Sem + II Sem) 24+24= 48								**73**

Audit course: All Lateral entry students have to register for Additional mathematics-I

1	18MATDIP31	Additional Mathematics-I	Mathematics	3	1	0	4	3	100	0	100	0

Course Code	18MAT31	Course Title	Engineering Mathematics – III	Semester	III
Credits	3	L – T – P –TL*	3 – 0 – 0 – 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to; • To have an insight into Fourier series, Fourier transforms, Laplace transforms, Difference equations and Z- transforms. • To develop the proficiency in variational calculus and solving ODE's arising in engineering applications, using numerical methods.	**Teaching Hrs**
Module-1 **Laplace Transforms:** Definition and Laplace transform of elementary functions. Properties of Laplace transforms (without proof). Laplace transforms of Periodic functions (statement only) and unit-step function – problems. **Inverse Laplace Transforms:** Inverse Laplace transform - problems, Convolution theorem to find the inverse Laplace transform (without proof) and problems, solution of linear differential equations using Laplace transforms.	**10**
Module-2 **Fourier series:** Periodic functions, Dirichlet's condition. Fourier series of periodic functions period 2□ and arbitrary period 2l. Fourier series of even and odd function. Half range Fourier series. Practical harmonic analysis, examples from engineering field.	**8**
Module-3 **Fourier Transforms:** Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transforms, simple problems. **Difference Equations and Z-Transforms:** Difference equations, basic definition, z-transform-definition, Standard z-transforms, Damping and shifting rules, initial value and final value theorems (without proof) and problems, Inverse z-transforms, simple problems.	**8**
Module-4 **Numerical Solutions of Ordinary Differential Equations (ODE's):** Numerical solution of ODE's of first order and first degree- Taylor's series method, Modified Euler's method. Runge - Kutta method of fourth order, Milne's and Adam's- Bashforth predictor and corrector method (No derivations of formulae), Problems.	**8**

Module-5	
Numerical Solution of Second Order ODE's: Runge -Kutta method and Milne's predictor and corrector method (No derivations of formulae)-Problems. **Calculus of Variations:** Variation of function and functional, variational problems, Euler's equation, Geodesics, hanging chain, problems.	**8**

Course outcomes: By the end of the course the student shall be able to:

CO1: Use Laplace transform and inverse Laplace transform in solving differential/ integral equation arising in network analysis, control systems and other fields of engineering.

CO2: Demonstrate Fourier series to study the behavior of periodic functions and their applications in system communications, digital signal processing and field theory.

CO3: Make use of Fourier transform and Z-transform to illustrate discrete/continuous function arising in wave and heat propagation, signals and systems.

CO4: Solve first and second order ordinary differential equations arising in engineering problems by applying single step and multistep numerical methods.

CO5: Determine the externals of functional using the calculus of variations and solve problems arising in the dynamics of Rigid bodies and vibration analysis.

Question paper pattern:

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

TEXT BOOKS:

1. Advanced Engineering Mathematics, E. Kreyszing, John Wiley & Sons, 10th Edition, 2016.
2. Higher Engineering Mathematics, B.S. Grewal, Khanna Publishers, 44th Edition, 2017

REFERENCE BOOKS

1. Higher Engineering Mathematics, B.V. Ramana, McGraw-Hill, 11th Edition, 2010.
2. A Text Book of Engineering Mathematics, N. P. Bali and Manish Goyal, Laxmi Publications, 2014.

Course Code	18ME32	Course Title	Strength of Materials	Semester	III
Credits	4	L – T – P –TL*	4 – 1 – 0 – 5	Teaching Hrs	56
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to; • To teach the student's knowledge of simple stress, strain and deformations of components due to external loads and study on the behavior of ductile and brittle materials. • To enable to assess stresses and deformations of Compound stresses and Torsion • To teach the student's knowledge of Shear Force, Bending Moment Diagram and Bending stress • To teach the student's knowledge of beams and columns • To provide the basic knowledge for use in the design courses.	Teaching Hrs
Module-1 **Simple Stress and Strain:** Introduction. Properties of material, Concept of Stress and Strain, Hook's Law, Stress Strain Diagram for structural steel and Non-ferrous materials. Poisson's Ratio & principles of superposition, Total elongation of tapering bars of circular and rectangular cross-sections. Elongation due to self-weight, Problems on deformations of member **Simple Stress & Strain – (Continued)** Composite section, Volumetric strain. Expression for Volumetric strain, Elastic constants, relationship among elastic constants, Thermal stresses including compound bars	12
Module-2 **Compound Stresses:** Introduction. Stress components on inclined planes. General two-dimensional stress system, Principal planes and stresses, Problems on principle plane stresses. Mohr's circle for biaxial stresses. **Thin and Thick Cylinders:** Introduction. Thin and thick cylinders subjected to pressure. Hoop stresses and longitudinal stresses. Problems on change in length, diameter and volume. Lame's equations. Problems on thick cylinder**.**	**12**
Module-3 **Bending Moment and Shear Force in Beams:** Introduction, Types of beams loadings and supports. Shearing force in beam. Bending moment, Sign convention. Relationship between loading shear force and bending moment. Expression for shear and bending moment equations, SFD and BMD with salient values for cantilever beams considering point load, UDL, UVL and Couple. SFD and BMD with salient values for simply supported and over hanging beams considering point load, UDL, UVL and Couple.	**12**
Module-4 **Bending Stress and Shear Stress in Beams:** Introduction, Bending stress in beam. Assumptions in simple	**10**

bending theory. Pure bending derivation of Flexure equation. Modulus of rupture, Section modulus, Flexural rigidity. Assumptions in theory of shear stresses in beams, Expression for horizontal shear stress in beam, Shear stress diagram for solid rectangular section and circular section **Deflection of Beams:** Introduction, Definitions of slope, deflection. Elastic curve-derivation of differential equation of deflection curve. Sign convention, slope and deflection standard loading using Macaulay's method, Problems on simply supported and overhanging beams to point load, UDL & Couple.	
Module-5 **Torsion of Circular Shafts:** Introduction. Pure torsion- General torsion equation. Strength and stiffness, Torsional rigidity, Torsional flexibility and polar modulus. Power transmitted by solid shaft. Power transmitted by hollow shaft. **Elastic stability of columns:** Introduction. Euler's theory on columns. Effective length, slenderness ratio. Short and long columns, Radius of gyration, Buckling load. Assumptions, derivations of Euler's Buckling load for different end conditions. Limitations of Euler's theory, Rankine's formula, related problems.	**10**

Course outcomes: By the end of the course, the student shall be able to

CO1: Describe the basic meaning of stress, strain diagrams for engineering materials.

CO2: Compute stress distribution in Compound bars, identify the stresses in torsional members and determine principal stresses in two dimensional systems.

CO3: Construct the shear force and bending moment diagrams for the beam.

CO4: Determine the deflections in beams and columns.

Question paper pattern:

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

Textbooks:

1. James G.Gere, "Mechanics of Materials", 5th Edition, 2004.Thomson Publishers. ISBN-0534417930
2. S.Ramamrutham, R. Narayanan, "Strength of Materials", Dhanphatrai publishing Co.Ltd.2003.ISBN-818743354X, 978818743354.

Reference Books:

1. Egor. P. Popov, "Engineering Mechanics of solids", Pearson education India, 2nd edition, 1998. ISBN-8120321073, 9788120321076
2. S. S. Bhavikatti, "Strength of Materials",Third edition, Vikas publications House – Pvt. Ltd.
3. Ferdinand Beer & Russell Jhonstan, "Mechanics of Materials", TMH 3rd Edition, 2003. ISBN – 0070535108, 9780070535107

Course Code	18ME33	Course Title	Basic Thermodynamics	Semester	III
Credits	4	L – T – P –TL*	4 – 1 – 0 – 5	Teaching Hrs	56
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

	Teaching Hr
Course Learning Objectives: This course will enable students to; • The course aims at to cover the basic principles of thermodynamics, to give students a feel for how thermodynamics is applied in engineering practice. • To develop an intuitive understanding of thermodynamics by emphasizing the physics and physical arguments. • To learn the basics of heat engine, heat pump, refrigerator and Carnot principle and their Practical applications. • To describe the concept of entropy and its importance in practical applications. • To teach students about properties of pure substances and process related to vapor.	
Module-1 **Fundamental Concepts & Definitions:** Definition of Thermodynamics. Microscopic and Macroscopic approaches to the study of thermodynamics. System and types of system. Definition of thermodynamic property, Intensive and extensive properties, thermodynamic state, process, quasi-static process, thermodynamic cycle. Thermodynamic equilibrium; definitions of thermal, chemical and mechanical equilibrium. Zeroth law of thermodynamics, Concept of Temperature with simple numerical problems on measurement of temperature. **Work and Heat:** Thermodynamic definition of work, sign convention. Exact & Inexact differentials. Displacement work; as a part of a system boundary, as a whole of a system boundary, expressions for displacement work in various processes through p-v diagrams. Definition of heat and its sign convention. Comparison of work and heat. Simple numerical problems on work and heat transfer only.	12
Module-2 **First Law of Thermodynamics**: Statement of the First law of thermodynamics for a closed system undergoing a cyclic process. First law of thermodynamics for a change of state of the system and concept of energy. Energy as a property of the system and its significance. Simple numerical problems on systems undergoing closed process. **Steady flow process**, First law applied to steady flow process, derivation of steady flow energy equation and its applications. Simple numerical problems on systems undergoing steady flow process.	12
Module-3 **Second Law of Thermodynamics:** Thermal reservoir. Source and sink. Heat engine, heat pump and refrigerator. Efficiency and coefficient of performance. Kelvin – Planck and Clausius statement of the Second law of thermodynamics and equivalence of the two Statements. Definition of perpetual motion machines of I & II kind with example. Reversible and Irreversible processes. Reversible heat engine - Carnot Cycle and expression for efficiency of Carnot cycle. Simple numerical problems on heat engines and heat pumps.	12

Module-4 **Pure substances:** Definition of pure substance, two-property rule applied to pure substance. P-T P-V & T-V diagrams, definitions of Sub-cooled liquid, saturated liquid, mixture, saturated vapour and superheated vapour. Definitions of triple point and critical point. Enthalpy of changes of a pure substance, temperature- Enthalpy diagram, Temperature Entropy diagram, definition of sensible heat, latent heat and super heat. Two phase mixture, quality of steam and definition of Dryness fraction. Measurement of dryness fraction using throttling calorimeter, separating calorimeter and throttling and separating calorimeter. Simple problems.	**10**
Module-5 **Entropy**: Claudius Inequality: Statement, and proof. Entropy: Definition, entropy as a property of the system. Principle of increase of entropy. Entropy as a quantitative test for irreversibility. Expression for entropy using T-dS relations, Calculation of entropy changes in different thermodynamic cyclic process. Equation of state, internal energy and enthalpy. Specific heats. Simple numerical problems based on heat, work, internal energy, enthalpy and entropy change in various processes. **Ideal gases:** Ideal gas mixtures, Daltons law of partial pressures, Amagat's law of additive volumes, evaluation of properties of perfect and ideal gases.	**10**
Course outcomes: By the end of the course, the student shall be able to CO1: Describe the fundamental concepts of thermodynamic systems and various processes of heat and work interactions CO2: Apply the First law of thermodynamics for flow and non-flow processes in different applications CO3: Explain the second law of thermodynamics, entropy and its applications CO4: Compute the properties of vapor, ideal and real gases.	
Question paper pattern: • The question paper will have ten full questions carrying equal marks. • Each full question will be for 20 marks. • There will be two full questions (with a maximum of four sub- questions) from each module. • Each full question will have sub- question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module.	
Textbooks: 1. P .K. Nag, **"Basic and Applied Thermodynamics"** Tata McGraw Hill, 3rd Edition, 2006. 2. B. K Venkanna, Swati B. Wadavadagi "Basic Thermodynamics, PHI, New Delhi, 2010. 3. R K Rajput, "**Engineering Thermodynamics"** Laxmi Publications Pvt Ltd, 3rd Edition, 2011. 4. Mahesh M Rathore, "**Thermal Engineering**" McGraw Hill Pvt Ltd., 1st Edition, New Delhi, 2010. **Reference Books:** 1. Yunus A. Cenegal and Michael A. Boles "Thermodynamics, An Engineering Approach", Tata McGraw Hill publications, 2002. 2. J. B. Jones and G. A. Hawkins "Engineering Thermodynamics", John Wiley and Sons. 3. G. J. Van Wylen and R. E. Sonntag "Fundamentals of Classical Thermodynamics", Wiley Eastern. **4.** Y. V. C. Rao"An Introduction to Thermodynamics, Wiley Eastern, 1993.	

Course Code	18ME34	Course Title	Manufacturing process-I	Semester	III
Credits	3	L – T – P –TL*	3 – 0 – 0 – 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to; • To provide understanding of the concept of material casting processes and to introduce the concept of dependent and independent variables which control materials casting. • To introduce the concept of selection of appropriate production processes for a specific application. • To introduce students to good foundry practices and product design considerations. • To provide understanding of the fundamentals of joining processes..	**Teaching Hr**
Module-1 **Manufacturing process**: Introduction to basic manufacturing, Classification of manufacturing process, Applications. **Casting:** Introduction, steps involved in making casting, Terminologies of casting, Advantages and limitations, Applications. **Pattern making**: Functions of pattern, Classification of pattern, Different pattern materials, various pattern allowances in design of pattern. **Mould making**: Types of moulds, Mould making, Desirable properties of Sand mould. Core making: Functions of cores, important factors in core design and making.	**08**
Module-2 **Moulding sand ingredients:** Types of base sand, Properties of base sand, Types of binders and its functions, various types of additives and its functions. **Gating system:** Concept of gating system, different types of gating systems, gating system design, risering design, 8umerical on gating and risering design. **Solidification:** Solidification of pure metal and alloy, Mechanisms of solidification, types of nucleation, grain structures. Progressive and directional solidification, solidification variables. Methods of achieving directional solidification **Defects in casting:** Introduction, types of defects, causes and remedies.	**08**
Module-3 **Special casting processes**: Shell molding, investment casting, Gravity die casting, Pressure die casting, Centrifugal casting, Slush casting, Continuous casting, Injection molding. CO2 mould. **Melting Furnaces**: Classification, constructional features and working principle of coke fired and Gas fired pit furnace, Resistance furnace, Electric arc furnace, Cupola furnace.	**08**

Module-4 **Welding Process:** Definition, Principles, Classification, Application, Advantages & limitations of welding. Gas welding, Oxy – Acetylene welding, Types of flame and Flame characteristics. **Electric Arc Welding:** Introduction to Arc welding, Classification of Arc welding, FSMAW, TIG, MIG, Arc welding current and voltage, Arc welding equipment's.	**09**
Module-5 **Soldering and Brazing:** Principles of soldering & brazing: Parameters involved & Mechanism, Different Types of Soldering & Brazing Methods. **Inspection Methods –** Methods used for Inspection of casting and welding-Visual, Magnetic particle, Fluorescent particle, Ultrasonic, Radiography, Eddy current, Holography methods of Inspection.	**09**

Course outcomes: By the end of the course, the student shall be able to

CO1: Define and explain the importance of casting process, steps involved in casting, patterns, binders, additives and molding machines.
CO2: Discuss the types of cores, types of metallic mold castings and melting furnaces.
CO3: Discuss the basic principles of different welding processes and their applications
CO4: Define and explain the basics of metallurgy of welding and identify the role of non destructive techniques in production processes.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

1. Foundry Technology, O.P. Khanna, Dhanpatrai publications (P)-2003 reprint.
2. Manufacturing Technology: Foundry, Forming and Welding, P N Rao, 2 nd Edition Tata McGraw-Hill publishing company Limited.

Reference Books:

1. S.K. HajraChoudhury (2001), **Elements of Workshop Technology, Vol-I**, Media Promoters Pvt Ltd., Mumbai.
2. S. Kalpakjian and S.R. Schmid, "**Manufacturing Engineering and Technology**", 7 th Edition, Prentice-Hall, 2013
3. Roy A. Lindberg (2004), **Processes and Materials of Manufacture**, 4th Edition, Prentice-Hall of India, New Delhi.
4. Banga T.R; and Agrawal R.L, "**Foundry Engineering**", Khanna Publishers, 1992.

Course Code	18ME35A	Course Title	Material Science	Semester	III
Credits	3	L – T – P –TL*	3 – 0 – 0 – 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to;	**Teaching Hr**
• To provide the basic knowledge required to explore the materials science and engineering. • To enhance the knowledge of the structure of materials which includes crystallography, microstructure, defects, and phase diagrams. • To develop the knowledge about the heat treatment process required for the metals. • To incorporate the knowledge in various class of materials and their applications.	
Module-1 **Crystalline Structure, Crystal Defects and Diffusion** Introduction, FCC, BCC, HCP with examples, , classification of engineering materials: single crystal, polycrystalline and amorphous material. Imperfections in solids: point, line, surface and volume defects. Diffusion: diffusion mechanism, steady state. Numerical on crystal structure and diffusion.Plastic deformation of single crystal by slip and twinning,	**08**
Module-2 **Mechanical behavior of Materials** **Creep** – Phenomenon, stages of creep and creep properties. **Fatigue-** Types of fatigue loads, fatigue properties, Fatigue test and S- N curves. **Fracture**: Mechanism of fracture, ductile and brittle fracture, Griffith's theory of fracture (only derivation), ductile to brittle transition.	**08**
Module-3 **Solidification and Phase Diagrams** Mechanism of solidification, homogeneous and heterogeneous solidification, Hume Rothary rules, substitution and interstitial solid solutions. Construction of phase diagram for binary systems, types of phase diagrams, Gibbs phase rule. lever rule. Iron carbon equilibrium diagram and invariant reactions. Numerical on lever rule.	**10**
Module-4 **Heat Treatment of Metals and Alloys** CCT and TTT diagrams, heat treatment of metals: Annealing method and its types. Normalizing, hardening, tempering, mar tempering, austempering. Hardenability-Jominy-end quench test, surface hardening methods:carburizing, cyaniding, nitriding, flame hardening and induction hardening, age hardening of aluminium-copper alloys.	**08**

Module-5	
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, hand layup , bag molding and Filament winding, Constitutive relations of composites, Numerical problems on determining properties of composites.	**08**

Course outcomes: By the end of the course student shall be able to

CO1: Recognize the classification of materials based on atomic arrangement and behavior of materials.
CO2: Enumerate the knowledge on different class of materials and their failures.
CO3: Illustrate the mechanism of solidification for various alloys.
CO4: Describe various types of heat treatment process require for strengthening of materials

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

1. James F Shackleford.& Madanapalli K Muralidhara, **Material science for Engineers,** Sixth edition, Pearson Publications - 2007
2. Smith, **Foundations of Materials Science and Engineering,** 4th Edition McGraw Hill, 2009.

Reference Books:

1. Alan Cottrell **An Introduction to Metallurgy** Universities Press India Oriental Longman Pvt. Ltd., 1974.
2. W.C.Richards **Engineering Materials Science**, PHI, 1965
3. V.Raghavan **Materials Science and Engineering**, , PHI, 2002
4. William D. Callister Jr., **Materials Science and Engineering**, John Wiley & Sons.Inc, 5th Edition, 2001.
5. Traugott Fischer, **Materials Science for Engineering Studies,** 2009. Elsevier Inc

Course Code	18ME36A	Course Title	Computer Aided Machine Drawing	Semester	III
Credits	3	L – T – P –TL*	2 – 0 – 3 – 5	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

	Teaching Hr
Course Learning Objectives: This course will enable students to; • To understand drawing and develop capacity to represent any object with the help of Picture. • To Sketch orthographic drawing of simple machine parts and threads. • To Sketch orthographic drawing of different fasteners, keys and rivets. • To Sketch orthographic drawing of Mechanical Joints and Couplings. • To Develop solid modelling skills to produce assembly drawings of mechanical components. • To develop creative thinking for developing the product concepts.	
Module-1 **Part – A** **Sections Of Solids:** Sections of Pyramids, Prisms, Cube, Tetrahedron, Cone and Cylinder resting only on their bases (No problems on axis inclinations, spheres and hollow solids). True shape of sections. **Orthographic Views:** Conversion of pictorial views into orthographic projections of simple machine parts with and without section. (Bureau of Indian standards conventions are to be followed for the drawings), Line conventions.	**8**
Module-2 **Part – B** **Thread Forms:** Thread terminology, sectional view of threads. ISO Metric (Internal & External), BSW (Internal & External), square and Acme threads, Buttress thread, Sellers thread, American Standard thread. **Fasteners:** Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut.	**6**
Module-3 **Riveted Joints**: Single and Double riveted lap joints, butt joints with single/double cover straps (chain and Zigzag, using snap head rivets).	**6**
Module-4 **Keys & Joints:** Study of keys: Parallel key, Taper key, feather key, Gibhead key and Woodruff key. Joints: cotter joint (socket and spigot), knuckle joint (pin joint), Universal joint. Couplings: Protected type flanged coupling, pin (bush) type flexible coupling, Muff coupling.	**6**

Module-5 **Part – C** **Assembly Drawings:** Solids of Protrusion, Assembly drawing of following machine parts (3D parts to be created and assemble and then getting 2D drawing with required views, including part drawing). 1. Screw Jack 2. Plummer Block (Pedestal Bearing) 3. Tailstock of a Lathe 4. Machine Vice 5. Tool head of a shaper 6. Rams Bottom safety Valve	**16**

Course outcomes: By the end of the course student shall be able to

CO1: Sketch detailed orthographic drawings of simple machine parts and threads

CO2: Construct hexagonal, square headed bolts and nuts, parallel key, taper key, Gib head key, woodruff key, single and double riveted lap joint, butt joints with single/double cover straps

CO3: Construct Cotter and Knuckle joint, Split Muff coupling, protected type flanged coupling. Pin type flexible coupling, Oldham's coupling and universal coupling.

CO4: Create solid assembly models of screw jack, pedestal bearing, machine-vice, I.C. engine connecting rod, tailstock of lathe, rams bottom safety valve, feed check valve.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module.

Scheme of Examination:
ONE question from part -A: 20 Marks
ONE question from part -B: 20 Marks
ONE question from part -C: 60 Marks
Total: 100 Marks (To be reduced to 60 marks)

Textbooks:

1. Machine Drawing by K. R. Gopalkrishna,; 2014, Publisher. Subhas Stores, ISBN: 4567142527
2. N.D. Bhat and V.M.Panchal, "Machine Drawing", Charotar Publishing House, 46th Edition, 2011, ISBN: 9789380358390
3. Tryambaka Murthy, "Machine Drawing", CBS Publications, 2nd Edition, 2008, ISBN: 9788123916590

Reference Books:

1. Machine Drawing by P.S.Gill, S.K.Kataria and Sons, Seventeenth Revised Edition, 2008.
2. Machine Drawing by N.D. Bhatt and V.M. Panchal, 48th edition (2013); Charotar Publishing House Pvt. Ltd., ISBN : 978-93-80358-69-7

Course Code	18ME37A	Course Title	Materials Testing Lab	Semester	III
Credits	2	L – T – P –TL*	1 –0 – 2 – 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to;

- To prepare the specimen for metallographic examination
- To study the wear characteristics of the given specimen
- To study the tensile , compressive and shear prosperities of metals and non-metals
- To evaluate Brinel, Vicker's and Rockwell's hardness of the materials
- To find impact strength of the given material
- To find the endurance limit of the material

Teaching Hr

List of Experiments

PART – A

1. Preparation of specimen for Metallographic examination of different engineering materials. Identification of microstructures of plain Carbon Steel, Tool Steel, Gray C.I, SG Iron, Brass, Bronze & Composites.
2. To study the wear characteristics of ferrous, non-ferrous and composite materials for different parameters.
3. Non-destructive tests,
    a. Magnetic particle test
    b. Dye penetration test.
4. Determination of density of Metals.

PART – B

1. Tensile, shear and compression tests of Metallic specimens using Universal Testing Machine
2. Torsion Test
3. Bending Test.
4. Izod and Charpy Tests.
5. Brinell, Rockwell and Vickers's Hardness test.

Course outcomes: By the end of the course the student shall be able to

CO1: Identify the type of material based on the microstructure using optical microscope.
CO2: Evaluate the wear properties.
CO3: Determine the defects in the given specimen using Ultrasonic flaw detection, Magnetic crack detection and Dye penetration test.
CO4: Determine tensile, compressive, torsional and bending properties of the given material using UTM.
CO5: Determine hardness of the given material & impact strength of the given material
CO6: Prepare the document based on the experiment/test conducted.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module.

Scheme of Examination:
ONE question from part -A: 30 Marks
ONE question from part -B: 50 Marks
Viva -Voice: 20 Marks Total: 100 Marks (To be reduced to 60 Marks)

Course Code	18ME38A	Course Title	Foundry and Forging Lab	Semester	III
Credits	2	L – T – P –TL*	1 – 0 – 2 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to;

- The course will introduce desirable properties of molding sand and establish its relevance in preparing the sand mold.
- To introduce the experimental procedure in determining the GFN, Permeability, Strength of mold, moisture & clay content in sand sample, core hardness & mold hardness.
- To bring in the effect of clay & water content on the various properties of molding sand.
- To give students hands on practice in preparing the sand moulds (Cope & Drag box) using single piece, split pattern and without using pattern.
- To give students hands on practice in preparing forging models using open -hearth furnace by performing upsetting, drawing & bending operation.
-

Teaching Hr

List of Experiments

PART – A

1. Testing of Moulding Sand and Core Sand:

Preparation of sand specimens and conduction of the following tests:

a. Compression and Shear test using Universal Sand Testing Machine.
b. Permeability test
c. Sieve analysis to find grain fineness number of base sand
d. Determination of clay content in base sand
e. Moisture content test in base sand

PART – B

2. Foundry Practice

a. Preparation of moulds with or without patterns.
(Single piece pattern and Split pin pattern)

PART – C

3. Forging Practice:

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

Course outcomes: By the end of the course the student shell be able to

CO1: Describe general properties of molding sand.
CO2: Determine the compression, shear, tensile strength & permeability of molding sand for different proportion of clay.
CO3: Identify the different tools used in foundry & Forging practice with their uses
CO4: Create the sand mold cavity using cope & drag box with pattern or without pattern
CO5: Demonstrate the upsetting, drawing & bending operation in preparing the forged model
CO6: Prepare the document based on the experiment/test conducted.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module.

Scheme of Examination:
ONE question from part -A: 30 Marks
ONE question from part –B/Part-C: 50 Marks
Viva -Voice: 20 Marks Total: 100 Marks (To Be reduced to 60 Marks)

Course Code	18ME35B	Course Title	Mechanical Measurements and Metrology	Semester	III
Credits	3	L – T – P –TL*	3 – 0 – 0 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to; • To impart the knowledge of importance of standards & conversion. • To introduce the fundamental concepts & derive the relations for the design of gauges, types of gauges, concepts involving comparators, angular measurements, • To explore the various aspects regarding the strain & temperature measurement	**Teaching Hr**
Module-1 **Linear and Angular measurement** Definition, objectives and concept of metrology, Classification of standards, Material Standard, Wavelength Standards, Line and End standards, , calibration of End bars (Numerical). Slip gauges-Indian standards on slip gauge, wringing of slip gauge, types of slip gauges, Numerical on building of slip gauges (M87, M112),Sine Bar and Sine centre, Bevel protractor, Numerical on angle gauge.	**08**
Module-2 **SYSTEM OF LIMITS, FITS, TOLERENCE AND GUAGING** Specification in assembly, Principle of interchangeability and selective assembly, limits of size, Indian standards, concept of limits of size and tolerances, definition of fits, hole basis system, shaft basis system, types of fits and their designation (IS 919-1963).Classification of gauges, brief concept of design of gauges (Taylor's principles), Numerical on design of Gauges.	**08**
Module-3 **MEASUREMENT OF THREAD PARAMETERS AND COMPARATORS** Terminology of screw threads, measurement of major diameter, minor diameter, 2-wire and 3-wire methods, best size wire. Functional requirements of comparators, classification, mechanical - dial indicator, Johnson Mikrokator, sigma comparators, Electrical Comparator, LVDT, Pneumatic comparator -back pressure, solex comparators and optical comparators-Zeiss ultraoptimeter.	**08**

Module-4 **MEASUREMENT SYSTEMS** Block diagram of generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold,sensitivity, hysteresis, repeatability, linearity, loading effect, Errors in measurement, classification of errors. Transducers, transfer efficiency, primary and secondary transducers, electrical, mechanical, electronic transducers. Mechanical systems, inherent problems, electrical intermediate modifying devices, ballast circuit. Terminating devices- Cathode ray oscilloscope, Oscillographs.	**09**
Module-5 **MEASUREMENT OF FORCE ,TORQUE,PRESSURE TEMPERATURE** Force-Static balance, equal and unequal balance and Platform balance, Torque- Absorption dynamometer, Prony brake and rope brake dynamometer, Pressure-Elastic members, Bridgeman gauge, McLeod gauge, Pirani gauge. Temperature-Thermocouple, law of thermocouple, materials used for construction of thermocouple, pyrometer and types	**09**

Course outcomes: By the end of the course students shall be able to

CO1: Distinguish between linear and angular measurements

CO2: Design of limit gauges for hole and shaft.

CO3: Explain various techniques used for measurement of pressure, speed and surface roughness.

CO4: Describe the concept of measuring force, torque, temperature and strain.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

1. R.K. Jain, **Engineering Metrology**, Khanna Publishers, 1994.
2. I.C.Gupta, **Engineering Metrology**Dhanpatrai publications.

Reference Books:

1. Beckwith Marangoni and Lienhard, **Mechanical Measurements**, Pearson Education, 6th Ed., 2006.
2. Bently, **Engineering Metrology and Measurements**, PearsonEducation.
3. Anand K. Bewoor&Vinay A. Kulkarni**Metrology & Measurement**, Tata McGraw.
4. N.V Raghavendra& L. Krishnamurthy, **Engineering Metrology and Measurements,** Oxford University Press.

Course Code	18ME36B	Course Title	Manufacturing Process - II	Semester	III
Credits	3	L – T – P –TL*	3 – 0 – 0 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to;	**Teaching Hr**
• To familiarize the student with tool nomenclature and cutting forces • To impart knowledge of machining parameters for different machining processes, tool life and tool wear. • To acquire the knowledge about various machining processes for production of complex shaped components. • To predict a suitable super finishing process to produce the intricate components.	
Module-1 **Theory of Metal Cutting**: Introduction -Geometry of a single point cutting tool - Chip formation and types of chips–Orthogonal and oblique cutting – Merchant circle diagram for cutting forces - Shear angle in terms of chip thickness ratio and rake angle, friction. Factors affecting cutting tool life – Types of tool wear – Taylor's tool life equation. **Cutting tool material**s: Desired properties, types of cutting tool materials –HSS, carbides coated carbides, ceramics, cutting fluids: Desired properties, types and selection. Heat generation in metal cutting, factors affecting heat generation,	**08**
Module-2 **Production Lathe:** Classification of Lathes, Specification, Engine lathe, Capstan & Turret lathe - constructional features, tool layout, tool &workholding devices and attachments. Lathe operations. **Shaping, Slotting and Planning Machines Tools**: Classification, constructional features of Shaper, Slotter, Planer. Driving mechanisms ofShaper, Slotter and Planer. Operations done on Shaper, Planer &Slotter. Difference between shaping and planning operations.	**08**
Module-3 **Drilling Machines:** Classification, constructional features, drilling & relatedoperations, types of drill & drill bit nomenclature, drill materials. **Milling Machines**: Principle of working, Classification of Milling machines, construction and working of Horizontal and vertical milling machines. Milling operations, methods of indexing, simple and compound indexing.	**08**
Module-4 **Grinding**: Working principle, constructional features of Cylindrical, Center less and Surface grinding machines, Types of abrasives, bonding process, marking of grinding wheels. Dressing and truing of grinding wheels. **Lapping, Honing and Broaching Machines** **Lapping** – Principle of Lapping – Lapping methods – Advantages and limitations of lapping **Honing** – Principle of honing – Types of honing machines – Advantages, limitations and applications of honing.	**09**

Module-5	
Broaching – Principle of working – Details of a commonly used broach – construction and working of a horizontal broaching machine – Advantages, limitations and applications. **TOOL WEAR, TOOL LIFE:** Introduction, tool wear mechanism, tool wear and tool failure, tool life, effects of cutting parameters on tool life, tool failure criteria, Taylor's tool life equation..	**09**

Course outcomes: By the end of the course student shall be able to

CO1: Analyze forces acting on the cutting tool in orthogonal and oblique cutting and various process parameters to improve the cutting tool life
CO2: Describe various machining process used for machining of components.
CO3: Explain various machines used for manufacturing of components.
CO4: Identify the cutting tools required for different machining processes.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module.

Text Books:

1. R.K Jain, **Production Technology**, Khanna Publications, 2003.
2. HMT, **Production Technology**, Tata McGraw Hill, 2001.

Reference Books:

1. Hajra Choudhury, **Workshop Technology Vol-II**, Media Promoters & Publishers Pvt. Ltd. 2004
2. Amitabh Ghosh and Mallik **Manufacturing Science**, East West Press, 2003
3. G.C Sen& Bhattacharya **Principle of Machine Tools**, Tata Mcgraw hill, New Delhi
4. Kalpakjian, serope **Manufacturing Engineering and Technology**, Addison –wesley publishing co., New york

Course Code	18MEL37B	Course Title	Mechanical Measurements and Metrology Lab	Semester	III
Credits	2	L – T – P –TL*	1 – 0 – 2 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to;	**Teaching Hr**
• To illustrate the theoretical concepts taught in Mechanical Measurements & Metrology through experiments. • To illustrate the use of various measuring tools and measuring techniques. • To understand calibration techniques of various measuring devices.	
List of Experiments **PART-A: MECHANICAL MEASUREMENTS** 1. Calibration of Pressure Gauge 2. Calibration of Thermocouple 3. Calibration of LVDT 4. Calibration of Load cell 5. Determination of modulus of elasticity of a mild steel specimen using strain gauges. **PART-B: METROLOGY** 1. Measurements using Optical Projector / Toolmaker Microscope. 2. Measurement of angle using Sine Center / Sine bar / bevel protractor 3. Measurement of alignment using Autocollimator / Roller set 4. Measurement of cutting tool forces using 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 outcomes: By the end of the course student shall be able to

CO1: To calibrate pressure gauge, thermocouple, LVDT, load cell, micrometer.

CO2: To measure angle using Sine Center/ Sine Bar/ Bevel Protractor, alignment using Autocollimator/ Roller set.

CO3: To demonstrate measurements using Optical Projector/Tool maker microscope, Optical flats. U PO1, CO4: To measure cutting tool forces using Lathe/Drill tool dynamometer.

CO5: To measure Screw thread parameters using 2-Wire or 3-Wire method, gear tooth profile using gear tooth vernier /Gear tooth micrometer.

CO6: To measure surface roughness using Tally Surf/ Mechanical Comparator.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module.

Scheme of Examination:
ONE question from part -A: 30 Marks
ONE question from part -B: 50 Marks
Viva -Voice: 20 Marks Total: 100 Marks (To be reduced to 60 Marks)

Course Code	18MEL38B	Course Title	MACHINE SHOP	Semester	III
Credits	2	L – T – P –TL*	1 – 0 – 2 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to; • To understand various operations carry out through various machines. • To provide knowledge about various machine tools. • To learn turning, milling and shaping operations. • Introduce measuring instruments and familiarize the students about measurement of surface roughness.	**Teaching Hr**
List of Experiments **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. **PART C** For demonstration Demonstration of formation of cutting parameters of single point cutting tool using bench grinder / tool & cutter grinder. Demonstration of surface milling /slot milling	
Course outcomes: By the end of the course the student shall be able to CO1: Identify the various operations required to prepare the model. CO2: Select the suitable machine for a particular operation. CO3: Prepare the specimen as per the given dimension for the given raw material. CO4: Demonstrate the measurement of cutting forces, thread parameters, gear parameters and angles of the component. CO5: Prepare the document based on the experiment/test conducted.	
Question paper pattern: • The question paper will have ten full questions carrying equal marks. • Each full question will be for 20 marks. • There will be two full questions (with a maximum of four sub- questions) from each module. • Each full question will have sub- question covering all the topics under a module. The students will have to answer five full questions, selecting one full question from each module. Scheme of Examination: ONE question from part -A: 30 Marks ONE question from part -B: 50 Marks Viva -Voice: 20 Marks Total: 100 Marks (To be reduced to 60 Marks)	

|| Jai Sri Gurudev||

ADICHUNCHANAGIRI UNIVERSITY

BGS Institute of Technology

B. E. Mechanical Engineering

Scheme for Fourth Semester Mechanical Engineering

Sl. No	Course Code	Title of the Course	Teaching Department	Teaching Hours/week				Examination				credits
				L	T	P	TL	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
1	18MAT41	Engineering Mathematics – IV	Mathematics	3	0	0	3	3	40	60	100	3
2	18ME42	Kinematics of Machines	ME	4	1	0	5	4	40	60	100	4
3	18ME43	Applied Thermodynamics	ME	4	1	0	5	4	40	60	100	4
4	18ME44	Fluid Mechanics	ME	4	1	0	5	4	40	60	100	4
	Group-A											
5	18ME45A	Materials Science	ME	3	0	0	3	3	40	60	100	3
6	18ME46A	Computer Aided Machine Drawing	ME	2	0	3	5	3	40	60	100	3
7	18MEL47A	Materials Testing Lab	ME	1	0	2	3	3	40	60	100	2
8	18MEL48A	Foundry and Forging Lab	ME	1	0	2	3	3	40	60	100	2
	Group-B											
5	18ME45B	Mechanical Measurements and Metrology	ME	3	0	0	3	3	40	60	100	3
6	18ME46B	Manufacturing process-II	ME	3	0	0	3	3	40	60	100	3
7	18MEL47B	Mechanical Measurements and Metrology Lab	ME	1	0	2	3	3	40	60	100	2
8	18MEL48B	Machine Shop	ME	1	0	2	3	3	40	60	100	2
9	18SSD 49	Soft Skill Development-2	HRD	0	2	0	2	2	20	30	50	1
10	18CIP 40	CIP (Non Credit Course)	Humanities	--	--	--	1	2	20	30	50	0
TOTAL CREDITS & CONTACT HOURS							**35**		**540**	**360**	**900**	**25**
TOTAL CREDITS OF I SEMESTER TO IV SEMESTER				(I Sem + II Sem+III Sem) 24+24+25= 73								**98**

Audit course: All Lateral entry students have to register for Additional mathematics-II

1	18MATDIP41	Additional Mathematics-II	Maths	3	1	0	4	3	100	0	100	0

Course Code	18MAT41	Course Title	Engineering Mathematics – IV	Semester	IV
Credits	3	L – T – P –TL*	3 – 0 – 0 – 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

	Teaching Hr
Course Learning Objectives: This course will enable students to; • To provide an insight into applications of complex variables, conformal mapping and special functions arising in potential theory, quantum mechanics, heat conduction and field theory. • To develop probability distribution of discrete, continuous random variables and joint probability distribution occurring in digital signal processing, design engineering and microwave engineering.	**10**
Module-1 **Calculus of complex functions:** Review of function of a complex variable, limits, continuity, and differentiability. Analytic functions: Cauchy-Riemann equations in Cartesian and polar forms and consequences. Construction of analytic functions (Milne Thomson method problems.	**8**
Module-2 **Conformal transformations**: Introduction. Discussion of transformations: $w = Z^2$, $w = e^z$, $w = z + \frac{1}{z}$, $z \neq 0$. Bilinear Transformations- Problems. Complex integration: Line integral of a complex function-Cauchy's theorem and Cauchy's integral formula and problems.	**8**
Module-3 **Probability Distributions:** Basic concepts of probability theory. Random variables (discrete and continuous), probability mass/density functions. Binomial, Poisson, exponential and normal distributions and problems.	**8**
Module-4 **Statistical Methods:** Correlation and regression-Karl Pearson's coefficient of correlation -problems. Regression analysis- lines of regression –problems. **Curve Fitting:** Curve fitting by the method of least squares- fitting the curves of the form $= ax + b$, $y = ax^b$ *and* $y = ax^2 + bx + c$.	**8**
Module-5 **Joint probability distribution:** Joint Probability distribution for two discrete random variables, expectation and covariance. **Sampling Theory:** Introduction to sampling distributions, standard error, Type-I and Type-II errors. Test of hypothesis for means. Stochastic process: Stochastic processes, probability vector, stochastic matrices, fixed points, regular stochastic matrices, Markov chains, higher transition probability – simple problems.	**8**

Course outcomes: By the end of the course student shall be able to

CO1: Use the concepts of analytic function and complex potentials to solve the problems arising in electromagnetic field theory.

CO2: make use of conformal transformation and complex integral arising in aerofoil theory, fluid flow visualization and image processing.

CO3: Apply discrete and continuous probability distributions in analyzing the probability models arising in engineering applications.

CO4: Make use of the correlation and regression analysis to fit a suitable mathematical model for the statistical data.

CO5: Construct joint probability distributions and demonstrate the validity of testing the hypothesis

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

3. Advanced Engineering Mathematics, E. Kreyszing, John Wiley & Sons, 10th Edition, 2016.
4. Higher Engineering Mathematics, B.S. Grewal, Khanna Publishers, 44th Edition, 2017.

Reference Books:

5. Higher Engineering Mathematics, B.V. Ramana, McGraw-Hill, 11th Edition, 2010.
6. A Text Book of Engineering Mathematics, N. P. Bali and Manish Goyal, Laxmi Publications, 2014.

Course Code	18ME42	Course Title	Kinematics of Machines	Semester	IV
Credits	4	L – T – P –TL*	4 – 1 – 0 – 5	Teaching Hrs	56
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

	Teaching Hr
Course Learning Objectives: This course will enable students to; • To teach the students to gain the Knowledge of Mechanisms, and their mobility. • To analyze velocity and acceleration for different mechanisms • To understand the fundamentals of gear teeth, types of gear, gear mesh and its arrangements. • To teach the kinematic analysis of cam- follower motion.	
Module-1 **Definitions:** Introduction to Link, Kinematic Pairs, Degrees of freedom. Kinematic chain, Mechanism, Inversion, Machine, Grubler's criterion, mobility of mechanism, Groshoff's criteria, inversions of Grashoff's chain. Four bar chain and its inversions, Single slider chain and its inversions, Double slider chain and its inversions, Kinematic chain with three lower pairs, Quick return motion mechanisms, Straight line mechanisms, Pantograph, Intermittent motion mechanisms, Toggle mechanism, Ackerman steering gear mechanism, Hooke's Joint	**12**
Module-2 **Velocity and Acceleration Analysis of Mechanisms (Graphical Method):** Velocity and acceleration analysis of four bar mechanism, slider crank mechanism. Mechanism illustrating Corioli's component of acceleration. Angular velocity and angular acceleration of links, velocity of rubbing. **Velocity and Acceleration Analysis of Mechanisms (Analytical Method):** Velocity and acceleration analysis of four bar mechanism, slider crank mechanism using complex algebra method	**12**
Module-3 **Spur Gears:** Gear terminology, law of gearing, path of contact, arc of contact, contact ratio of spur gear. Interference in involute gears, methods of avoiding interference, condition and expressions for minimum number of teeth to avoid interference., Back lash, comparison of involute & cycloidal teeth. Problems on Gears, **Gear Trains:** Simple gear trains, compound gear trains. Epicyclic gear trains: Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains, torque calculation in epicyclic gear trains.	**12**
Module-4 **Belt Drives**: Friction and Belt Drives: Definitions: Types of friction: laws of friction, Friction in pivot and collar bearings. Belt drives: Flat belt drives. Ratio of belt tensions, centrifugal tension, power transmitted **Chain drives**: Classification, construction of roller chain and silent chain. Advantages and disadvantages.	**10**

Module-5	
Cams: Types of cams, Types of followers, Displacement, Velocity and Acceleration time curves for cam profiles. Disc cam with reciprocating follower having knife-edge, roller and flat-faced follower, Disc cam with oscillating roller follower, Follower motions including SHM, Uniform velocity, uniform acceleration and retardation and cycloidal motion. **Analysis of Cams:** Analysis of arc cam with flat faced follower. Circular arc cam operating flat faced and roller followers. Undercutting in Cams. .	**10**

Course outcomes: By the end of the course the student shall be able to

CO1: Differentiate between a machine and mechanism, its degrees of freedom, possible inversions and classify mechanism with lower pair based on applications.

CO2: Determine the velocity and acceleration of simple mechanisms.

CO3: Analyze various types of gears and gear arrangements

CO4: Draw various types of cams and follower based on motion

Question paper pattern:

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

TEXT BOOKS:

1. Thomas Bevan., Theory of Machines, C.B.S Publishers, 2005. ISBN-8123908741.
2. Rattan S.S., Theory of Machines, TMH , Third Edition, 2011. ISBN-13:978-0-07-0144774.

REFERENCE BOOKS:

1. Shigley. J. V. and Uickers, J. Theory of Machines & Mechanisms TMH, 6th Edition, 2003. ISBN-04718-0237-9, ISBN-019515598X.
2. Theory of Machines by Sadhu Singh, Pearson Education (Singapore) Pvt. Ltd. 2nd edition 2007.
3. Mechanism and Machine Theory, A.G.Ambekar, PHI, 2007

Course Code	18ME43	Course Title	Applied Thermodynamics	Semester	IV
Credits	4	L – T – P –TL*	4– 1 – 0 – 5	Teaching Hrs	56
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

	Teaching Hr
Course Learning Objectives: This course will enable students to; • To describe the basic principles of applied thermodynamics, to give students a feel for how thermodynamics is applied in engineering practice. • To develop an intuitive understanding of thermodynamics by emphasizing the physics and physical arguments. • To read the basics of combustion, air fuel ratio required and their Practical applications. • To discuss the concept of refrigeration and its importance in practical applications. • To teach students about properties of moist air and process related to moist air • To generalize the application of P-H diagram in vapor compression refrigeration process.	
Module-1 **Air standard cycles**: Assumptions, network output, air standard efficiency and mean effective pressure of Carnot cycle, Otto cycle, Diesel cycle, Dual combustion cycle, Sterling cycle, Atkinson cycle. Comparison of Otto, Diesel and Dual combustion cycle.	**12**
Module-2 **Vapour power cycles:** Carnot vapor power cycle and its performance. Simple Rankine cycle, description, T-S diagram, and Expression for efficiency. Effects of maximum pressure, exhaust pressure and maximum temperature on the performance of simple Rankine cycle. Deviation of simple Rankine cycle from ideal cycles Analysis of Reheat Cycle, Ideal regenerative cycle, practical regenerative cycles with open and closed type feed water heaters.	**12**
Module-3 **Testing of I.C. engines**: Testing of two-stroke and four strokes SI and CI engines. Performance Factors, Basic testing factors and basic measurements for engine performance. Indicated Power, Friction Power: Willan‟s line method, Morse Test, and Motoring test. Brake Power: Fuel consumption: volumetric type. Air consumption: Air Box Method to determine air consumption. Heat balance sheet and related numerical problems.	**12**

Module-4 **Reciprocating Compressors**: Introduction, general description and classification, volumetric efficiency, work done, need for multi staging, optimum intermediate pressure for two stage air Compressor with inter-cooling, work required for Multistage compressor and its efficiency.	**10**
Module-5 **Refrigeration and Air Conditioning:** Introduction, cop, unit of refrigeration, air refrigeration, Carnot cycle, Bell-Coleman cycle, vapour compression refrigeration cycle, p-h chart, calculation of work and cop of vapour compression cycle, effect of operating conditions, vapour absorption cycle. Introduction to air conditioning, principle, psychometric, psychometric processes, types of air conditioning with simple numerical.	**10**

Course outcomes: By the end of the course the students shall be able to

CO1: Explain various air standard cycles and evaluate the performance of the various cycles

CO2: Evaluate various performance parameters of IC engines and Rankine cycle

CO3: Demonstrate working of turbines and compressor.

CO4: Apply the concept of refrigeration and air conditioning to evaluate performance of the system.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module.

TEXT BOOKS:

1. Basic and Applied Thermodynamics by P K Nag, Tata Mcgraw Hill pub. Co., 2002.
2. R K Rajput "Engineering Thermodynamics" Laxmi Publications, 4th Edition, ISBN: 9788131800584.
3. Mahesh M Rathore "Thermal Engineering" Tata McGraw Hill, 1st edition.

REFERENCE BOOKS:

1. Fundamental of classical Thermodynamics by G J Van Wylen and RE Sonntag, Wiley Eastern.
2. Internal combustion engines by M.L. Mathur and R.P. Sharma, Dhanpatrai publications,2003
3. Thermal Engineering by B K Sarkar, Tata McGraw-Hill Education Pvt. Ltd., 2004

Course Code	18ME44	Course Title	Fluid mechanics	Semester	IV
Credits	4	L – T – P –TL*	4 – 1 – 0 –5	Teaching Hrs	56
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

	Teaching Hr
Course Learning Objectives: This course will enable students; • To identify the flow characteristic and dynamics of flow field for various Engineering Applications. • To recall how velocity changes and energy transfers in fluid flows are related to forces and torques and • To discuss why designing for minimum loss of energy in fluid flows is so important. • To discuss the main properties of laminar and turbulent pipe flow and appreciate their differences and the concept of boundary layer theory. • To describe the concept of dynamic similarity and how to apply it to experimental modeling	
Module-1 **Properties of Fluids:** Introduction, Types of fluid, Properties of fluids-mass density, weight density, specific volume, specific gravity, viscosity, thermodynamic properties, compressibility and bulk modulus- relationship between modulus and pressure of gas, surface tension, capillarity, Vapour pressure and Cavitation. **Fluid Statics:** Definition – pressure, atmospheric pressure, absolute pressure, gauge pressure, vacuum pressure. Pressure at a point, Pascal's law of pressure, manometers (Simple & differential U tube manometer), hydrostatic force on submerged plane surfaces and curved surfaces, Buoyancy and stability criteria determination of Met centric height by analytical method.	**12**
Module-2 **Fluid Kinematics:** Fluid flow concepts, types of fluid flow, continuity equation in 1D and 3D (Cartesian co-ordinate system only) dimensions, stream function and velocity potential function for 2-D flow, relationship between them and vortices, flow nets **Fluid Dynamics:** General energy and momentum equations, Euler's equation of motion along a stream line, Bernoulli's equation derived from Fundamentals & Euler's equation, Bernoulli's equation for real fluid	**12**
Module-3 **Flow through Pipes:** Friction loss in pipe, Darcy's and Chezy's equation for loss of head due to friction in pipes. Minor losses through pipes. Hydraulic gradient line and total energy line. **Dimensional Analysis:** Dimensions of physical quantities, dimensional homogeneity- Rayleigh's method, Buckingham's π theorem, important dimension less numbers, similitude.	**12**

Module-4 **Laminar flow and Viscous Effects:** Reynolds number, critical Reynolds number, laminar flow through circular pipe- Hagen Poiseuille's equation, laminar flow between parallel and stationary plates. **Flow past Immersed Bodies:** Drag, Lift, pressure and friction drag, Boundary layer concept and calculation of laminar boundary layers thickness, displacement & momentum thickness.	**10**
Module-5 **Introduction to compressible Flow:** Velocity of sound in a fluid, Mach number, Mach cone, propagation of pressure waves in a compressible fluid. **Fluid Flow measurements:** Flow measurement devices such as Venturimeter, Orifice meter, Pitot tube, V-Notch and rectangular notches.	**10**

Course outcomes: By the end of the course student shall be able to

CO1: Explain the kinematics characteristics of fluid flow.

CO2: Apply the principles of fluid dynamics and dimensional analysis.

CO3: Apply the concept of fluid flow through pipe and around immersion bodies to find frictional losses and forces.

CO4: Illustrate the basic concept of Impact of jets and Centrifugal pumps.

CO5: Demonstrate the main and operating characteristics of hydraulic turbines.

Question paper pattern:

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

TEXT BOOKS:

1. YunusA.Cengal, John M Oimbala, Fluid Mechanics,TMH., 2006. ISBN-007117202
2. Dr. R.K.Bansal, "Fluid mechanics and hydraulic machines" Laxmi publications Ltd., New Delhi. 9th edition, 2015, ISBN: 9788131808153.
3. R.K.Rajput, Fluid Mechanics, S Chand 2008. ISBN-8121916674

REFERENCE BOOKS:

1. Som and Biswas, Introduction to Fluid Mechanics and Machinery,TMH.,2005. ISBN-0-07-0494975
2. John F. Douglas, Janul and M. Gasiosek and John. A. Swaffield, Fluid Mechanics, Pearson Education Asia 5th Edition, 2006. ISBN-10:0131292935, ISBN- 13:978-0131292932
3. White, Fluid Mechanics,5th Edt. TMH 2003. ISBN: 0072402172
4. Dr.K.L.Kumar, "Engineering Fluid Mechanics" S Chand Lltd., 2010, ISBN: 9788121901000

Course Code	18ME45A	Course Title	Material Science	Semester	IV
Credits	3	L – T – P –TL*	3 – 0 – 0 – 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

	Teaching Hr
Course Learning Objectives: This course will enable students to; • To provide the basic knowledge required to explore the materials science and engineering. • To enhance the knowledge of the structure of materials which includes crystallography, microstructure, defects, and phase diagrams. • To develop the knowledge about the heat treatment process required for the metals. • To incorporate the knowledge in various class of materials and their applications.	
Module-1 **Crystalline Structure, Crystal Defects and Diffusion** Introduction, FCC, BCC, HCP with examples, , classification of engineering materials: single crystal, polycrystalline and amorphous material. Imperfections in solids: point, line, surface and volume defects. Diffusion: diffusion mechanism, steady state. Numerical on crystal structure and diffusion.Plastic deformation of single crystal by slip and twinning,	**08**
Module-2 **Mechanical behavior of Materials** **Creep** – Phenomenon, stages of creep and creep properties. **Fatigue-** Types of fatigue loads, fatigue properties, Fatigue test and S- N curves. **Fracture**: Mechanism of fracture, ductile and brittle fracture, Griffith's theory of fracture (only derivation), ductile to brittle transition.	**08**
Module-3 **Solidification and Phase Diagrams** Mechanism of solidification, homogeneous and heterogeneous solidification, Hume Rothary rules, substitution and interstitial solid solutions. Construction of phase diagram for binary systems, types of phase diagrams, Gibbs phase rule. lever rule. Iron carbon equilibrium diagram and invariant reactions. Numerical on lever rule.	**10**
Module-4 **Heat Treatment of Metals and Alloys** CCT and TTT diagrams, heat treatment of metals: Annealing method and its types. Normalizing, hardening, tempering, mar tempering, austempering. Hardenability-Jominy-end quench test, surface hardening methods:carburizing, cyaniding, nitriding, flame hardening and induction hardening, age hardening of aluminium-copper alloys.	**08**

Module-5	08
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, hand layup , bag molding and Filament winding, Constitutive relations of composites, Numerical problems on determining properties of composites.	

Course outcomes: By the end of the course student shall be able to

CO1: Recognize the classification of materials based on atomic arrangement and behavior of materials.
CO2: Enumerate the knowledge on different class of materials and their failures.
CO3: Illustrate the mechanism of solidification for various alloys.
CO4: Describe various types of heat treatment process require for strengthening of materials

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

1. James F Shackleford.& Madanapalli K Muralidhara, **Material science for Engineers,** Sixth edition, Pearson Publications - 2007
2. Smith, **Foundations of Materials Science and Engineering,** 4th Edition McGraw Hill, 2009.

Reference Books:

1. Alan Cottrell **An Introduction to Metallurgy** Universities Press India Oriental Longman Pvt. Ltd., 1974.
2. W.C.Richards **Engineering Materials Science**, PHI, 1965
3. V.Raghavan **Materials Science and Engineering**, , PHI, 2002
4. William D. Callister Jr., **Materials Science and Engineering**, John Wiley & Sons.Inc, 5th Edition, 2001.
5. Traugott Fischer, **Materials Science for Engineering Studies,** 2009. Elsevier Inc

Course Code	18ME46A	Course Title	Computer Aided Machine Drawing	Semester	IV
Credits	3	L – T – P –TL*	2 – 0 – 3– 5	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to;	Teaching Hr
• To understand drawing and develop capacity to represent any object with the help of Picture. • To Sketch orthographic drawing of simple machine parts and threads. • To Sketch orthographic drawing of different fasteners, keys and rivets. • To Sketch orthographic drawing of Mechanical Joints and Couplings. • To Develop solid modelling skills to produce assembly drawings of mechanical components. • To develop creative thinking for developing the product concepts.	
Module-1 **Part – A** **Sections Of Solids:** Sections of Pyramids, Prisms, Cube, Tetrahedron, Cone and Cylinder resting only on their bases (No problems on axis inclinations, spheres and hollow solids). True shape of sections. **Orthographic Views:** Conversion of pictorial views into orthographic projections of simple machine parts with and without section. (Bureau of Indian standards conventions are to be followed for the drawings), Line conventions.	**8**
Module-2 **Part – B** **Thread Forms:** Thread terminology, sectional view of threads. ISO Metric (Internal & External), BSW (Internal & External), square and Acme threads, Buttress thread, Sellers thread, American Standard thread. **Fasteners:** Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut.	**6**
Module-3 **Riveted Joints**: Single and Double riveted lap joints, butt joints with single/double cover straps (chain and Zigzag, using snap head rivets).	**6**
Module-4 **Keys & Joints:** Study of keys: Parallel key, Taper key, feather key, Gibhead key and Woodruff key. Joints: cotter joint (socket and spigot), knuckle joint (pin joint), Universal joint. Couplings: Protected type flanged coupling, pin (bush) type flexible coupling, Muff coupling.	**6**

Module-5 **Part – C** **Assembly Drawings:** Solids of Protrusion, Assembly drawing of following machine parts (3D parts to be created and assemble and then getting 2D drawing with required views, including part drawing). 1. Screw Jack 2. Plummer Block (Pedestal Bearing) 3. Tailstock of a Lathe 4. Machine Vice 5. Tool head of a shaper 6. Rams Bottom safety Valve	**16**

Course outcomes: By the end of the course student shall be able to

CO1: Sketch detailed orthographic drawings of simple machine parts and threads

CO2: Construct hexagonal, square headed bolts and nuts, parallel key, taper key, Gib head key, woodruff key, single and double riveted lap joint, butt joints with single/double cover straps

CO3: Construct Cotter and Knuckle joint, Split Muff coupling, protected type flanged coupling. Pin type flexible coupling, Oldham's coupling and universal coupling.

CO4: Create solid assembly models of screw jack, pedestal bearing, machine-vice, I.C. engine connecting rod, tailstock of lathe, rams bottom safety valve, feed check valve.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module.

Scheme of Examination:
ONE question from part -A: 20 Marks
ONE question from part -B: 20 Marks
ONE question from part -C: 60 Marks
Total: 100 Marks (To be reduced to 60 marks)

Textbooks:

1. Machine Drawing by K. R. Gopalkrishna,; 2014, Publisher. Subhas Stores, ISBN: 4567142527
2. N.D. Bhat and V.M.Panchal, “Machine Drawing”, Charotar Publishing House, 46th Edition, 2011, ISBN: 9789380358390
3. Tryambaka Murthy, “Machine Drawing”, CBS Publications, 2nd Edition, 2008, ISBN: 9788123916590

Reference Books:

1. Machine Drawing by P.S.Gill, S.K.Kataria and Sons, Seventeenth Revised Edition, 2008.
2. Machine Drawing by N.D. Bhatt and V.M. Panchal, 48th edition (2013); Charotar Publishing House Pvt. Ltd., ISBN : 978-93-80358-69-7
3. Machine Drawing – N. Sidheshwar, P. Kannaiah, V.V.S. Sastry , McGraw Hill Edition 48th ISBN 10: 007460337X/ ISBN 13: 9780074603376

Course Code	18ME47A	Course Title	Materials Testing Lab	Semester	IV
Credits	2	L – T – P –TL*	1 –0 – 2 – 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to;	**Teaching Hr**
• To prepare the specimen for metallographic examination • To study the wear characteristics of the given specimen • To study the tensile , compressive and shear prosperities of metals and non-metals • To evaluate Brinel, Vicker's and Rockwell's hardness of the materials • To find impact strength of the given material • To find the endurance limit of the material	

List of Experiments

PART – A

5. Preparation of specimen for Metallographic examination of different engineering materials. Identification of microstructures of plain Carbon Steel, Tool Steel, Gray C.I, SG Iron, Brass, Bronze & Composites.
6. To study the wear characteristics of ferrous, non-ferrous and composite materials for different parameters.
7. Non-destructive tests,
    a. Magnetic particle test
    b. Dye penetration test.
8. Determination of density of Metals.

PART – B

6. Tensile, shear and compression tests of Metallic specimens using Universal Testing Machine
7. Torsion Test
8. Bending Test.
9. Izod and Charpy Tests.
10. Brinell, Rockwell and Vickers's Hardness test.

Course outcomes: By the end of the course the student shall be able to

CO1: Identify the type of material based on the microstructure using optical microscope.
CO2: Evaluate the wear properties.
CO3: Determine the defects in the given specimen using Ultrasonic flaw detection, Magnetic crack detection and Dye penetration test.
CO4: Determine tensile, compressive, torsional and bending properties of the given material using UTM.
CO5: Determine hardness of the given material & impact strength of the given material
CO6: Prepare the document based on the experiment/test conducted.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module.

Scheme of Examination:
ONE question from part -A: 30 Marks
ONE question from part -B: 50 Marks
Viva -Voice: 20 Marks Total: 100 Marks (To be reduced to 60 Marks)

Course Code	18ME48A	Course Title	Foundry and Forging Lab	Semester	IV
Credits	2	L – T – P –TL*	1 – 0 – 2 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

	Teaching Hr
Course Learning Objectives: This course will enable students to; 1. The course will introduce desirable properties of molding sand and establish its relevance in preparing the sand mold. 2. To introduce the experimental procedure in determining the GFN, Permeability, Strength of mold, moisture & clay content in sand sample, core hardness & mold hardness. 3. To bring in the effect of clay & water content on the various properties of molding sand. 4. To give students hands on practice in preparing the sand moulds (Cope & Drag box) using single piece, split pattern and without using pattern. 5. To give students hands on practice in preparing forging models using open -hearth furnace by performing upsetting, drawing & bending operation.	
List of Experiments **PART – A** **1. Testing of Moulding Sand and Core Sand:** Preparation of sand specimens and conduction of the following tests: f. Compression and Shear test using Universal Sand Testing Machine. g. Permeability test h. Sieve analysis to find grain fineness number of base sand i. Determination of clay content in base sand j. Moisture content test in base sand **PART – B** **2. Foundry Practice** b. Preparation of moulds with or without patterns. (Single piece pattern and Split pin pattern) **PART – C** **3. Forging Practice:** b. Preparing minimum three forged models involving upsetting, drawing and bending operations.	
Course outcomes: By the end of the course the student shell be able to CO1: Describe general properties of molding sand. CO2: Determine the compression, shear, tensile strength & permeability of molding sand for different proportion of clay.	

CO3: Identify the different tools used in foundry & Forging practice with their uses
CO4: Create the sand mold cavity using cope & drag box with pattern or without pattern
CO5: Demonstrate the upsetting, drawing & bending operation in preparing the forged model
CO6: Prepare the document based on the experiment/test conducted.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module.

Scheme of Examination:
ONE question from part -A: 30 Marks
ONE question from part –B/Part-C: 50 Marks
Viva -Voice: 20 Marks Total: 100 Marks (To Be reduced to 60 Marks)

Course Code	18ME45B	Course Title	Mechanical Measurements and Metrology	Semester	IV
Credits	3	L – T – P –TL*	3 – 0– 0 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to; • To impart the knowledge of importance of standards & conversion. • To introduce the fundamental concepts & derive the relations for the design of gauges, types of gauges, concepts involving comparators, angular measurements, • To explore the various aspects regarding the strain & temperature measurement	**Teaching Hr**
Module-1 **Linear and Angular measurement** Definition, objectives and concept of metrology, Classification of standards, Material Standard, Wavelength Standards, Line and End standards, , calibration of End bars (Numerical). Slip gauges-Indian standards on slip gauge, wringing of slip gauge, types of slip gauges, Numerical on building of slip gauges (M87, M112),Sine Bar and Sine centre, Bevel protractor, Numerical on angle gauge.	**08**
Module-2 **SYSTEM OF LIMITS, FITS, TOLERENCE AND GUAGING** Specification in assembly, Principle of interchangeability and selective assembly, limits of size, Indian standards, concept of limits of size and tolerances, definition of fits, hole basis system, shaft basis system, types of fits and their designation (IS 919-1963).Classification of gauges, brief concept of design of gauges (Taylor's principles), Numerical on design of Gauges.	**08**
Module-3 **MEASUREMENT OF THREAD PARAMETERS AND COMPARATORS** Terminology of screw threads, measurement of major diameter, minor diameter, 2-wire and 3-wire methods, best size wire. Functional requirements of comparators, classification, mechanical - dial indicator, Johnson Mikrokator, sigma comparators, Electrical Comparator, LVDT, Pneumatic comparator -back pressure, solex comparators and optical comparators-Zeiss ultraoptimeter.	**08**

Module-4 **MEASUREMENT SYSTEMS** Block diagram of generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold,sensitivity, hysteresis, repeatability, linearity, loading effect, Errors in measurement, classification of errors. Transducers, transfer efficiency, primary and secondary transducers, electrical, mechanical, electronic transducers. Mechanical systems, inherent problems, electrical intermediate modifying devices, ballast circuit. Terminating devices- Cathode ray oscilloscope, Oscillographs.	**09**
Module-5 **MEASUREMENT OF FORCE ,TORQUE,PRESSURE TEMPERATURE** Force-Static balance, equal and unequal balance and Platform balance, Torque- Absorption dynamometer, Prony brake and rope brake dynamometer, Pressure-Elastic members, Bridgeman gauge, McLeod gauge, Pirani gauge. Temperature-Thermocouple, law of thermocouple, materials used for construction of thermocouple, pyrometer and types	**09**

Course outcomes: By the end of the course students shall be able to

CO1: Distinguish between linear and angular measurements

CO2: Design of limit gauges for hole and shaft.

CO3: Explain various techniques used for measurement of pressure, speed and surface roughness.

CO4: Describe the concept of measuring force, torque, temperature and strain.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

1. R.K. Jain, **Engineering Metrology**, Khanna Publishers, 1994.
2. I.C.Gupta, **Engineering Metrology**Dhanpatrai publications.

Reference Books:

1. Beckwith Marangoni and Lienhard, **Mechanical Measurements**, Pearson Education, 6th Ed., 2006.
2. Bently, **Engineering Metrology and Measurements**, PearsonEducation.
3. Anand K. Bewoor&Vinay A. Kulkarni**Metrology & Measurement**, Tata McGraw.

4.N.V Raghavendra& L. Krishnamurthy, **Engineering Metrology and Measurements,** Oxford University Press.

Course Code	18ME46B	Course Title	Manufacturing Process - II	Semester	IV
Credits	3	L – T – P –TL*	3– 0 – 0 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

	Teaching Hr
Course Learning Objectives: This course will enable students to; 1. To familiarize the student with tool nomenclature and cutting forces 2. To impart knowledge of machining parameters for different machining processes, tool life and tool wear. 3. To acquire the knowledge about various machining processes for production of complex shaped components. 4. To predict a suitable super finishing process to produce the intricate components.	
Module-1 **Theory of Metal Cutting**: Introduction -Geometry of a single point cutting tool - Chip formation and types of chips–Orthogonal and oblique cutting – Merchant circle diagram for cutting forces - Shear angle in terms of chip thickness ratio and rake angle, friction. Factors affecting cutting tool life – Types of tool wear – Taylor's tool life equation. **Cutting tool material**s: Desired properties, types of cutting tool materials –HSS, carbides coated carbides, ceramics, cutting fluids: Desired properties, types and selection. Heat generation in metal cutting, factors affecting heat generation.	**08**
Module-2 **Production Lathe:** Classification of Lathes, Specification, Engine lathe, Capstan & Turret lathe - constructional features, tool layout, tool &workholding devices and attachments. Lathe operations. **Shaping, Slotting and Planning Machines Tools**: Classification, constructional features of Shaper, Slotter, Planer. Driving mechanisms ofShaper, Slotter and Planer. Operations done on Shaper, Planer &Slotter. Difference between shaping and planning operations.	**08**
Module-3 **Drilling Machines:** Classification, constructional features, drilling & relatedoperations, types of drill & drill bit nomenclature, drill materials. **Milling Machines**: Principle of working, Classification of Milling machines, construction and working of Horizontal and vertical milling machines. Milling operations, methods of indexing, simple and compound indexing.	**08**
Module-4 **Grinding**: Working principle, constructional features of Cylindrical, Center less and Surface grinding machines, Types of abrasives, bonding process, marking of grinding wheels. Dressing and truing of grinding wheels. **Lapping, Honing and Broaching Machines** **Lapping** – Principle of Lapping – Lapping methods – Advantages and limitations of lapping **Honing** – Principle of honing – Types of honing machines – Advantages, limitations and applications of honing.	**09**

Module-5	
Broaching – Principle of working – Details of a commonly used broach – construction and working of a horizontal broaching machine – Advantages, limitations and applications. **TOOL WEAR, TOOL LIFE:** Introduction, tool wear mechanism, tool wear and tool failure, tool life, effects of cutting parameters on tool life, tool failure criteria, Taylor's tool life equation..	**09**

Course outcomes: By the end of the course student shall be able to

CO1: Analyze forces acting on the cutting tool in orthogonal and oblique cutting and various process parameters to improve the cutting tool life
CO2: Describe various machining process used for machining of components.
CO3: Explain various machines used for manufacturing of components.
CO4: Identify the cutting tools required for different machining processes.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module.

Text Books:

1. R.K Jain, **Production Technology**, Khanna Publications, 2003.
2. HMT, **Production Technology**, Tata McGraw Hill, 2001.

Reference Books:

1. Hajra Choudhury, **Workshop Technology Vol-II**, Media Promoters & Publishers Pvt. Ltd. 2004
2. Amitabh Ghosh and Mallik **Manufacturing Science**, East West Press, 2003
3. G.C Sen& Bhattacharya **Principle of Machine Tools**, Tata Mcgraw hill, New Delhi
4. Kalpakjian, serope **Manufacturing Engineering and Technology**, Addison –wesley publishing co., New york

Course Code	18MEL47B	Course Title	Mechanical Measurements and Metrology Lab	Semester	IV
Credits	2	L – T – P –TL*	1 – 0 – 2 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60
*NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total; CIE – Continuous Internal Evaluation; SEE – Semester End Examination					

Course Learning Objectives: This course will enable students to; 1. To illustrate the theoretical concepts taught in Mechanical Measurements & Metrology through experiments. 2. To illustrate the use of various measuring tools and measuring techniques. 3. To understand calibration techniques of various measuring devices.	**Teaching Hr**
List of Experiments **PART-A: MECHANICAL MEASUREMENTS** 1. Calibration of Pressure Gauge 2. Calibration of Thermocouple 3. Calibration of LVDT 4. Calibration of Load cell 5. Determination of modulus of elasticity of a mild steel specimen using strain gauges. **PART-B: METROLOGY** 1. Measurements using Optical Projector / Toolmaker Microscope. 2. Measurement of angle using Sine Center / Sine bar / bevel protractor 3. Measurement of alignment using Autocollimator / Roller set 4. Measurement of cutting tool forces using 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 outcomes: By the end of the course student shall be able to

CO1: To calibrate pressure gauge, thermocouple, LVDT, load cell, micrometer.
CO2: To measure angle using Sine Center/ Sine Bar/ Bevel Protractor, alignment using Autocollimator/ Roller set.
CO3: To demonstrate measurements using Optical Projector/Tool maker microscope, Optical flats. U PO1,
CO4: To measure cutting tool forces using Lathe/Drill tool dynamometer.
CO5: To measure Screw thread parameters using 2-Wire or 3-Wire method, gear tooth profile using gear tooth vernier /Gear tooth micrometer.
CO6: To measure surface roughness using Tally Surf/ Mechanical Comparator.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module.

Scheme of Examination:
ONE question from part -A: 30 Marks
ONE question from part -B: 50 Marks
Viva -Voice: 20 Marks Total: 100 Marks (To be reduced to 60 Marks)

Course Code	18MEL48B	Course Title	MACHINE SHOP	Semester	IV
Credits	2	L – T – P –TL*	1 – 0 – 2 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to;	**Teaching Hr**
• To understand various operations carry out through various machines. • To provide knowledge about various machine tools. • To learn turning, milling and shaping operations. • Introduce measuring instruments and familiarize the students about measurement of surface roughness.	
List of Experiments **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. **PART C** **For demonstration**: Demonstration of formation of cutting parameters of single point cutting tool using bench grinder / tool & cutter grinder. Demonstration of surface milling /slot milling	

Course outcomes: By the end of the course the student shall be able to

CO1: Identify the various operations required to prepare the model.
CO2: Select the suitable machine for a particular operation.
CO3: Prepare the specimen as per the given dimension for the given raw material.
CO4: Demonstrate the measurement of cutting forces, thread parameters, gear parameters and angles of the component.
CO5: Prepare the document based on the experiment/test conducted.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module.

Scheme of Examination:
ONE question from part -A: 30 Marks
ONE question from part -B: 50 Marks
Viva -Voice: 20 Marks Total: 100 Marks (To be reduced to 60 Marks)

|| Jai Sri Gurudev||

ADICHUNCHANAGIRI UNIVERSITY

BGS Institute of Technology

B. E. Mechanical Engineering

Scheme for 5th Semester Mechanical Engineering

Sl. No	Course Code	Title of the Course	Teaching Department	Teaching Hours/week				Examination				Credits
				L	T	P	TL	Duration in Hrs	CIE Marks	SEE Marks	Total Marks	
1	18ME51	Management & Entrepreneurship	ME	2	1	0	3	3	40	60	100	3
2	18ME52	Dynamics of Machines	ME	4	1	0	5	3	40	60	100	4
3	18ME53	Turbo Machines	ME	4	1	0	5	3	40	60	100	4
4	18ME54	Machine Design -I	ME	4	1	0	5	3	40	60	100	4
Professional Elective-– 1												
5	18ME551	Composite Materials	ME	3	0	0	3	3	40	60	100	3
	18ME552	Non Traditional Machining	ME	3	0	0	3	3	40	60	100	3
	18ME553	Statistical Quality Control	ME	3	0	0	3	3	40	60	100	3
Professional Elective-– 2												
6	18ME561	Theory of Elasticity	ME	3	0	0	3	3	40	60	100	3
	18ME562	Smart Materials & Structures	ME	3	0	0	3	3	40	60	100	3
	18ME563	Automation and Robotics	ME	3	0	0	3	3	40	60	100	3
7	18MEL57	Fluid Mechanics and Machines Lab	ME	1	0	2	3	3	40	60	100	2
8	18MEL58	Energy Conversion Lab	ME	1	0	2	3	3	40	60	100	2
9	18SSD59	Soft Skill Development-3	HRD	0	2	0	2	2	30	20	50	1
10	18Yoga 60	Yoga	PED	--	--	1	1	0	50	--	50	0
TOTAL CREDITS & CONTACT HOURS							**33**		**400**	**500**	**900**	**26**
TOTAL CREDITS OF I SEMESTER TO V SEMESTER				(I Sem + II Sem+III Sem+IV Sem) 24+24+25+25= 98								**124**

Course Code	18ME51	Course Title	Management and Entrepreneurship	Semester	V
Credits	3	L – T – P –TL*	2 – 1 – 0 – 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to; • Examine the meaning, importance, nature of management, its difference between management and administration and role of managers in management. • Examine the meaning characteristics principles and process of organizing. • Describe effective communication process, its importance, types and purpose for running an organization. • Understand the need for Entrepreneurs and their skills. • Explain the importance of engineering economics, Law of demand and supply in engineering decision making.	**Teaching Hrs**
Module-1 **Management:** Introduction - Meaning - nature and characteristics of Management, Scope and Functional areas of management - Management as a science, art of profession - Management & Administration - Roles of Management, Levels of Management, and Development of Management Thought early management approaches – Modern management approaches. **Planning:** Nature, importance and purpose of planning process Objectives -Types of plans (Meaning Only) - Decision making Importance of planning -steps in planning & planning premises - Hierarchy of plans.	**10**
Module-2 **Organizing and Staffing:** Nature and purpose of organization Principles of organization - Types of organization - Departmental Committees Centralization Vs Decentralization of authority and responsibility - Span of control - MBO and MBE (Meaning Only) **Nature and importance of staffing--:** Process of Selection & Recruitment (in brief).	**8**
Module-3 **Directing & Controlling:** Meaning and nature of directing Leadership styles, Motivation Theories, Communication - Meaning and importance - coordination, meaning and importance and Techniques of Co Ordination. **Meaning and steps in controlling -** Essentials of a sound control system - Methods of establishing control (in brief)	**8**

Module-4 **Entrepreneurship:** Definition of Entrepreneur, Importance of Entrepreneurship, concepts of Entrepreneurship, Characteristics of successful Entrepreneur, Classification of Entrepreneurs, Myths of Entrepreneurship. **Entrepreneurial Development**: Models, Entrepreneurial development cycle, Problems faced by Entrepreneurs and capacity building for Entrepreneurship	**8**
Module-5 **Engineering and economics**: Problem solving and decision making, Laws of demand and supply, Difference between Microeconomics & Macroeconomics, equilibrium between demand & supply, elasticity of demand, price elasticity, income elasticity. **Returns and Interest**: Law of Returns, Interest and interest factors, simple and compound interest, Cash flow diagrams, personal loans and EMI payment calculation with flexible interest rates, Discussion and problems.	**8**

Course outcomes: By the end of the course the student shall be able to:

CO1: Explain the development of management and the role it plays at different levels in an organization.

CO2: Comprehend the process and role of effective planning, organizing and staffing for the development of an organization.

CO3: Analyze the necessity of good leadership, communication and coordination for establishing effective control in an organization.

CO4: Describe the functions of Managers, Entrepreneurs and their social responsibilities

CO5: Calculate the engineering demand, supply and its importance in economics decision making and problem solving

Question paper pattern:

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

TEXT BOOKS:

1. Principles of Management by Tripathy and Reddy, Tata McGraw-Hill Education.
2. Entrepreneurship Development Small Business Enterprises- Poornima M Charantimath, Pearson Education 2008, ISBN 978-81-7758-260-4.
3. Engineering Economy, Thuesen H.G. PHI , 2002

REFERENCE BOOKS

1. Management Fundamentals- Concepts, Application, Skill Development - RobersLusier – Thomson.
2. Basics of Engineering Economy, Leland Blank & Anthony Tarquin, McGraw Hill Publication (India) Private Limited.
3. Engineering Economics, R.Paneerselvam, PHI publication.
4. Fundamentals of Management: Essential Concepts and Applications, Robbins S.P. and Decenzo David A, Pearson Education.

Course Code	18ME52	Course Title	Dynamics of Machines	Semester	V
Credits	4	L – T – P –TL*	4 – 1 – 0 – 5	Teaching Hrs	56
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

	Teaching, Hrs
Course Learning Objectives: This course will enable students to; • Understand the force-motion relationship in components subjected to external forces and analysis of standard mechanisms. • Study the undesirable effects of unbalances resulting from prescribed motions in mechanism. • Explain the principles in mechanisms used for speed control and stability control. • Understand the principles in engine torque and turning moment diagram. • Analyze and design different types of Cams.	
Module-1 **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. **Dynamic force Analysis:** D'Alembert's principle, Inertia force, Inertia torque. Dynamic force analysis of four-bar mechanism and Slider crank mechanism without friction, numerical problems.	**12**
Module-2 **Fly wheel:** Engine output torque, Flywheel design for I.C. Engine and size for punching press, typical applications of Fly wheel, Fly wheel for energy storage, Coefficient for speed fluctuations and energy. **Turning moment diagrams** : I.C. Engines and multi cylinder Engine, Maximum Fluctuation of Energy.	**10**
Module-3 **Balancing of Rotating Masses:** Static and dynamic balancing, balancing of single rotating mass by balancing masses in same plane and in different planes. Balancing of several rotating masses by balancing masses in same plane and in different planes. **Balancing of Reciprocating Masses:** Inertia effect of crank and connecting rod, Single cylinder engine, balancing in multi cylinder-inline engine (primary and secondary forces), numerical problems.	**12**
Module-4 **Governors:** Types of governors, force analysis of Porter and Hartnell governors. Controlling force, Stability, Sensitiveness, Isochronisms, Effort and Power. **Analysis of Cams:** Analysis of Tangent cam with roller follower and Circular arc cam operating flat faced and roller followers. Undercutting in Cams.	**12**

Module-5	
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. **Vibrations:** Introduction, Definitions, Types of vibrations, Simple Harmonic Motion (SHM), Work done by harmonic force, Principle of super position applied to SHM.	**10**

Course outcomes: By the end of the course the student shall be able to

CO1: Carry out graphical and analytical analysis of Static and Dynamic forces on Mechanisms.
CO2: Analyze the function, design and control of flywheels.
C03: Do Balancing of rotating masses and reciprocating masses using graphical and analytical methods.
CO4: Calculate the speed and lift of the governor and analysis of different types of Cams.
CO5: Estimate the gyroscopic effect on automobiles, ships and airplanes.

Question paper pattern:

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

Text Books:

1. Thomas Bevan., Theory of Machines, C.B.S Publishers, 2005. ISBN-8123908741.
2. Rattan S.S., Theory of Machines, TMH , Third Edition, 2011. ISBN-13:978-0-07-0144774.

Reference Books:

1. Shigley. J. V. and Uickers, J. Theory of Machines & Mechanisms TMH, 6th Edition, 2003. ISBN-04718-0237-9, ISBN-019515598X.
2. Theory of Machines by Sadhu Singh, Pearson Education (Singapore) Pvt. Ltd. 2nd edition 2007.
3. Mechanism and Machine Theory, A.G.Ambekar, PHI, 2007
4. P.L. Ballaney, Theory of Machines & Mechanisms, Khanna Publishers, 25th edition edition, 2005. ISBN: 9788174091222.

Course Code	18ME53	Course Title	Turbo Machines	Semester	V
Credits	4	L – T – P –TL*	4 – 1 – 0 – 5	Teaching Hrs	56
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to; • Understand the working principle, application and thermodynamics process involved in turbo machines. • Study the conversion of fluid energy to mechanical energy in Turbo machine with utilization factor and degree of reaction. • Analyze various designs of steam turbine and their working principle. • Study the various designs of hydraulic turbine based on the working principle. • Understand the various aspects in design of power absorbing machine.	**Teaching, Hrs**
Module-1 **Introduction**: Definition of a turbo machine, Parts of a turbo machine, Comparison with positive displacement machine, Classification of turbo machines, dimensionless parameters and their significance, Effect of Reynolds number, Unit and specific quantities, model studies. **Turbines:** Discussions on various efficiencies of Pelton wheel, Francis turbines and Kaplan turbines, Numerical.	**10**
Module-2 **Energy Transfer in Turbo Machine (Power producing machines):** Euler Turbine equation, Alternate form of Euler turbine equation and components of energy transfer. Degree of reaction, general expression for degree of reaction. Utilization factor, relation between utilization factor and degree of reaction. **General Analysis of Turbo machines**: Condition for maximum utilization in Impulse, reaction and 50% reaction turbines. Velocity triangles for different values of degree of reaction. Comparison of impulse and reaction turbines, Numerical.	**12**
Module-3 **Steam Turbine**: Classification, methods of compounding, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, Need, Multi-stage impulse turbine, expression for maximum utilization factor. **Reaction turbine –**Parsons's turbine, condition for maximum utilization factor, reaction staging, Numerical.	**12**
Module-4 **Hydraulic Turbines:** Classification, various efficiencies. Pelton Wheel – Principle of working, velocity triangles,	**12**

design parameters, maximum efficiency, Numerical. **Francis turbine**: Principle of working, velocity triangles, design parameters, and numerical problems, Kaplan and Propeller turbines - Principle of working, velocity triangles, design parameters and Numerical Problems. Theory and types of Draft tubes, Numerical.	
Module-5 **Centrifugal Pumps:** Centrifugal pumps, introduction and main part of the centrifugal pump, Work done and velocity triangles, Head developed manometric head, suction head, delivery head and static head. Pump losses and efficiency. Minimum starting speed, net positive suction head, priming. Multistage centrifugal pumps and Cavitations in centrifugal pumps, Numerical. **Axial flow pumps:** Description, velocity triangles, work done on the fluid and energy transfer or head.	**10**

Course outcomes: By the end of the course the students should be able to:

CO1: Apply the principles and operations of Turbo-machines and the use of velocity triangles.
CO2: Analyze the energy transfer in Turbo machine with degree of reaction and utilization factor.
CO3: Classify, analyze the various types of steam turbine.
CO4: Apply basics of fluid machines of hydraulic turbines.
CO5: Evaluate the performance parameters of pumps with the use of velocity triangles.

Question paper pattern:

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

Textbooks:

1. V Kadambi and Monohar Prasad, "An Introduction to Energy Conversion," Volume III, Turbo machinery, New Age International Private Limited, 2011, ISBN: 978- 8122431896.
2. M. S. Govindegouda and A. M. Nagaraj, "Text Book of Turbo Machines ,"M. M. Publications, 4th Ed, 2008.
3. B K Venkanna, "Fundamentals of Turbomachinary," PHI Learning Pvt Limited, 2009, ISBN: 978-8120337756.

Reference Books:

1. S. M. Yahya, "Turbines Compressors and Fans," Tata McGraw Hill Education, 4th Edition, 2010, ISBN: 978-0070707023.
2. D. G. Shepherd, "Principles of Turbo Machinery," Macmillan Company, 1964.

Course Code	18ME54	Course Title	Machine Design-1	Semester	V
Credits	4	L – T – P –TL*	3 – 1 – 0 – 4	Teaching Hrs	56
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to; • Design of simple machine elements subjected to static and dynamic loads • Learn the concepts of stress analysis • Understand the theories of failure.	**Teaching Hrs**
Module-1 **Introduction:** Design Process: Definition of design, phases of design, and review of engineering materials and their properties and manufacturing processes; use of codes and standards, selection of preferred sizes. Review of axial, bending, shear and torsion loading on machine components, combined loading, two- and three dimensional stresses, principal stresses, stress tensors, Mohr's circles. **Theories of failure:** maximum normal stress theory, maximum shear stress theory, distortion energy theory, strain energy theory, Columba –Mohr theory and modified Mohr's theory. **Stress concentration**, stress concentration factor and methods of reducing stress concentration.	**12**
Module-2 **Impact loads**: Impact Strength: Introduction, Impact stresses due to axial, bending and torsion loads. **Fatigue loading:** Introduction to fatigue failure, Mechanism of fatigue failure, types of fatigue loading, S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit. Modifying factors: size effect, surface effect, Stress concentration effects Notch sensitivity, Soderberg and Goodman relationships, stresses due to combined loading, cumulative fatigue damage, and Miners equation.	**12**
Module-3 **Design of shafts:** Torsion of shafts, solid and hollow shaft design with steady loading based on strength and rigidity, ASME and BIS codes for power transmission shafting, design of shafts subjected to combined bending, torsion and axial loading. Design of shafts subjected to fluctuating loads **Design of keys and couplings :**Keys: Types of keys and their applications, design considerations in parallel and tapered sunk keys, Design of square and rectangular sunk keys. Couplings: Rigid and flexible coupling-types and applications, design of Flange coupling, and Bush and Pin type coupling.	**12**

Module-4 **Design of Permanent Joints:** Types of permanent joints-Riveted and Welded Joints. Riveted joints: Types of rivets, rivet materials, Caulking and fullering, analysis of riveted joints, joint efficiency, failures of riveted joints, boiler joints, riveted brackets. **Welded joints:** Types, strength of butt and fillet welds, eccentrically loaded welded joints	**10**
Module-5 **Design of Temporary Joints:** Types of temporary joints- cotter joints, knuckle joint and fasteners. Design of Cotter and Knuckle Joint. Threaded Fasteners: Stresses in threaded fasteners, effect of initial tension, design of threaded fasteners under static, dynamic and impact loads, design of eccentrically loaded bolted joints**.** **Power screws:** Mechanics of power screw, stresses in power screws, efficiency and self-locking, design of power screws.	**10**

Course outcomes: After a successful completion of the course, the student will be able to:

CO1. Apply basic stress-strain analysis and failure theories to design machine elements.
CO2. Analyze and solve problems on machine elements subjected to dynamic loads.
CO3. Design temporary and permanent fasteners.
CO4. Design power screws for different applications.

Question paper pattern:

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

Textbooks:

1.Maleev & Hartman's, Machine Design in SI units, 5th Edition, C B S Publications, Delhi, 2005.ISBN:9788123906379

Reference Books:

1. Joseph Edward Shigley, Mechanical Engineering Design, Mc. Graw Hill, 8th Edition, 2008. ISBN:9780073529288.
2. V.B.Bhandari, Design of Machine Elements, TMH, 3rd Edition, 2007.ISBN: 9780070681748.

Design Data Hand Books:

1. K. Mahadevan and Balaveera Reddy, Design Data Hand Book, C B S Publications, Delhi. ISBN:9788123901626.
2.Design Data Hand Book, K. Lingaiah, McGraw Hill, 2nd edition, 2003.

Course Code	18ME551	Course Title	Composite Materials	Semester	V
Credits	3	L – T – P –TL*	2 – 1 – 0 – 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

	Teaching Hrs
Course objectives: This course will enable students to; • Understand the concepts of modern composite materials and their applications. • Equip them with knowledge on how to fabricate and carry out standard mechanical test on composites.	
Module-1 **Introduction to composite materials:** Definition, Classification, Types of matrices & reinforcements, characteristics & selection, Fiber composites, laminated composites, particulate composites, prepegs, sandwich construction. **Analysis:** Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance. Advantages and application of composites	**8**
Module-2 **Micro mechanical analysis of a lamina:** Introduction, Evaluation of the four elastic moduli – Rule of mixture, Numerical Problems. **Macro mechanics of a lamina:** Hooke's law for different types of materials, number of elastic constants, Laminate code,	**8**
Module-3 **Manufacturing:** Layup and curing - open and closed mould processing, Hand lay-up techniques, Bag moulding and filament winding. Pultrusion, Pulforming, Thermoforming, Injection moulding, Cutting, Machining, joining and repair. **Testing:** NDT test –Purpose, Types of defects, NDT method - Ultrasonic inspection, Radiography, Acoustic emission and Acoustic ultrasonic method.	**8**
Module-4 **Fabrication Process for Metal Matrix Composites (MMC's)**: Powder metallurgy technique, liquid metallurgy technique, special fabrication techniques. **Design of Fibre Reinforced Composite structures:** Introduction, Composite structural design, Design criteria, Laminate design, Mathematical analysis of the laminate, Design of composite stiffeners.	**10**
Module-5 **Application:** Aircrafts, missiles, space hardware, automobile, electrical and electronics, marine, recreational and	**8**

sports equipment-future potential of composites. **Metal matrix composites**: Reinforcement materials, types, Characteristics & Selection, base metals-selection, applications.	

Course outcomes: After a successful completion of the course, the student will be able to:

CO1. Identify and explain the types of composite materials and their characteristic features

CO2. Explain the differences in the strengthening mechanism of composite and its corresponding effect on performance and application

CO3. Explain the methods employed in composite fabrication.

CO4. Suggest the composite materials for different applications.

Question paper pattern:

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

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 - 1st edition 1997.

Reference Books:

1. Hand Book of Composite Materials by Ed-Lubin
2. Composite Materials – K.K.Chawla
3. Composite Materials Science and Applications – Deborah D.L. Chung
4. Composite Materials Design & Applications – Danial Gay, Suong V. Hoa, & Stephen W. Tasi.

Course Code	18ME552	Course Title	Non Traditional Machining	Semester	V
Credits	3	L – T – P –TL*	2 – 1 – 0 – 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to; • To understand the principle, mechanism of metal removal of various non-traditional machining processes. • To study the various process parameters and their effect on component machined on various non-traditional machining processes. • To understand the applications of different processes	**Teaching Hrs**
Module - 1 **Introduction:** Introduction to Non-traditional machining, Need for Non-traditional machining process, Comparison between traditional and non-traditional machining, general classification Non-traditional machining processes, classification based on nature of energy employed in machining, selection of non-traditional machining processes, Specific advantages, limitations and applications of non-traditional machining processes **Water Jet Machining (WJM):** Equipment & process, Operation, applications, advantages and limitations of WJM.	**8**
Module – 2 **Ultrasonic Machining (USM):** Introduction, Equipment and material process, Effect of process parameters: Effect of amplitude and frequency, Effect of abrasive grain diameter, effect of slurry, tool & work material. Process characteristics: Material removal rate, tool wear, accuracy, surface finish, applications, advantages & limitations of USM. **Abrasive Jet Machining (AJM):** Introduction, Equipment and process of material removal, process variables: carrier gas, type of abrasive, work material, stand-off distance (SOD).Process characteristics-Material removal rate, Nozzle wear, accuracy & surface finish. Applications, advantages & limitations of AJM.	**10**
Module – 3 **ELECTROCHEMICAL MACHINING (ECM):** Introduction, Principle of electro chemical machining: ECM equipment, elements of ECM operation, Chemistry of ECM. ECM Process characteristics: Material removal rate, accuracy, surface finish. Process parameters: Current density, Tool feed rate, Gap between tool & work piece, velocity of electrolyte flow, type of electrolyte, its concentration temperature, and choice of electrolytes. Applications ECM: Electrochemical grinding and electrochemical honing process. Advantages, disadvantages and application of ECG, ECH. **CHEMICAL MACHINING (CHM):** Elements of the process: Resists (maskants), Etchants. Types of chemical machining process-chemical blanking process, chemical milling process. Process characteristics of CHM: material removal rate, accuracy, surface finish, advantages, limitations and applications of chemical machining process.	**8**

Module – 4 **ELECTRICAL DISCHARGE MACHINING (EDM):** Introduction, mechanism of metal removal, EDM equipment: spark erosion generator (relaxation type), dielectric medium-its functions & desirable properties, electrode feed control system. Flushing types; pressure flushing, suction flushing, side flushing, pulsed flushing. EDM process parameters: Spark frequency, current & spark gap, surface finish, Heat Affected Zone. Advantages, limitations & applications of EDM. **PLASMA ARC MACHINING (PAM):** Introduction, non-thermal generation of plasma, equipment mechanism of metal removal, Plasma torch, process parameters, process characteristics. Safety precautions. Safety precautions, applications, advantages and limitations.	**8**
Module – 5 **LASER BEAM MACHINING (LBM):** Introduction, generation of LASER, Equipment and mechanism of metal removal, LBM parameters and characteristics, Applications, **ELECTRON BEAM MACHINING (EBM):** Introduction, Principle, equipment and mechanism of metal removal, applications, Advantages & limitations.	**8**

Course outcomes: After a successful completion of the course, the student will be able to:

CO1. Compare traditional and non-traditional machining process and recognize the need for Non-traditional machining process.
CO2. Explain constructional features, performance parameters, process characteristics, applications, advantages and limitations of USM, AJM and WJM.
CO3. Identify the need of Chemical and electro-chemical machining process along with the constructional features, process parameters, process characteristics, applications, advantages and limitations.
CO4. Explain constructional feature of the equipment, process parameters, process characteristics, applications, advantages and limitations EDM & PAM.
CO5. Enlighten LBM equipment, LBM parameters, and characteristics. EBM equipment and mechanism of metal removal, applications, advantages and limitations LBM & EBM.

Question paper pattern:

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

TEXT BOOKS:

1. Modern Machining Process by P.C Pandey and H S Shah, McGraw Hill Education India Pvt. Ltd. 2000
2. Production technology, HMT, McGraw Hill Education India Pvt. Ltd. 2001

REFERENCE BOOKS

1. New Technology, Dr. Amitabha Bhattacharyya, The Institute of Engineers (India), 2000
2. Modern Machining process, Aditya, 2002.

Course Code	18ME553	Course Title	Statistical Quality Control	Semester	V
Credits	3	L – T – P –TL*	2 – 1 – 0 – 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to; • Introduce the concept of SQC • Understand the process control and control charts • Acceptance sampling procedure and their applications	**Teaching Hrs**
Module - 1 Introduction: The Meaning of Quality and Quality Improvement; Brief History of Quality Methodology; Statistical Methods for Quality Control and Improvement; Total Quality Management (quality philosophy, links between quality and productivity, quality costs, legal aspects of quality implementing, quality improvement	**8**
Module – 2 **Modeling Process Quality:** Mean, Median, Mode, Standard deviation, Calculating area, The Deming funnel experiment, Normal distribution tables, Finding the Z score, Central limit theorem.	**8**
Module – 3 **Control Charts For Variables:** Chance and assignable causes, Statistical Basis of the Control Charts (basic principles, choices of control limits, significance of control limits, sample size and sampling frequency, rational subgroups, analysis of pattern on control charts, warning limits, Control Charts for X-Bar and R- Charts	**8**
Module – 4 **Control Charts for attributes:** control charts for proportion or fraction defectives-p chart and np chart- control chart for defects- C and U charts **Process Capability:** The foundation of process capability, Natural Tolerance limits, cp – process capability index, cpk, pp – process performance index, summary of process measures. Numerical problems	**10**
Module – 5 **Acceptance Sampling For Attributes:** The acceptance sampling problem, single sampling plan for attributes, Double, Multiple, and Sequential sampling, AOQL, LTPD, OC curves, Numerical problems.	**8**
Course outcomes: After a successful completion of the course, the student will be able to: 1. Explain the attributes in process control charts. 2. Plot and assess the control charts for variables	

3. Identify the defects and defectives by control charts of attributes
4. Appreciate the role of sampling procedure & identify process capability

Question paper pattern:

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

Text Books:

1. Statistical Quality Control, Montgomery, Douglas, 5th Edition, John Wiley & Sons, Inc. 2005, Hoboken, NJ (ISBN 0-471-65631-3).
2. Statistical Quality Control, RC Gupta, Khanna Publishers, New Delhi, 2005
3. Statistical Quality Control, M Mahajan, Dhanpat Rai Publishing Co Pvt Ltd, New Delhi, ISBN13 9788177000399

Reference Books:

1. Statistical Process Control and Quality Improvement, Gerald M. Smith, Pearson Prentice Hall. ISBN 0 – 13-049036-9.
2. Statistical Quality Control for Manufacturing Managers, W S Messina, Wiley & Sons, Inc. New York, 1987
3. Principles of Quality Control, Jerry Banks, Wiley & Sons, Inc. New York.

Course Code	18ME561	Course Title	Theory of Elasticity	Semester	V
Credits	3	L – T – P –TL*	3 – 0 – 0 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course objectives: This course will enable students to; 1. Gain knowledge of stresses and strains in 3D and their relations. 2. Understand the 2D analysis of elastic structural members. 3. Gain knowledge of thermal stresses and stability of columns 4. Analysis of elastic members for the stresses and strains induced under direct loading conditions. 5. Know the analysis of axi-symmetric and torsional members	**Teaching Hrs**
Module-1 **Analysis of Stress:** Definition and notation of stress, equations of equilibrium in differential form, stress components on an arbitrary plane, equality of cross shear, stress invariants, principal stresses, octahedral stress, planes of maximum shear, stress transformation, plane state of stress, Numerical problems	**8**
Module-2 **Analysis of Strain:** Displacement field, strains in term of displacement field, infinitesimal strain at a point, engineering shear strains, strain invariants, principal strains, octahedral strains, plane state of strain, compatibility equations, strain transformation, Numerical Problems.	**8**
Module-3 Two-Dimensional classical elasticity Problems: Cartesian co-ordinates - Relation between plane stress and plane strain, stress functions for plane stress and plane strain state, Airy's stress functions, Investigation of Airy's stress function for simple beams, bending of a narrow cantilever beam of rectangular cross section under edge load. Bending of simply supported beam under UDL. General equations in polar coordinates, stress distribution symmetrical about an axis, Thick wall cylinder subjected to internal and external pressures, Numerical Problems.	**10**
Module-4 Axisymmetric and Torsion problems: Stresses in rotating discs of uniform thickness and cylinders. Torsion of circular, elliptical and triangular bars, Prandtl's membrane analogy, torsion of thin walled thin tubes, torsion of thin walled multiple cell closed sections. Numerical Problems	**8**
Module-5 Thermo elastic stress strain relations, equations of equilibrium, thermal stresses in thin circular discs and in long circular cylinders. Euler's column buckling load: clamped-free, clamped-hinged, clamped-clamped and pin-ended, Numerical Problems	**8**

On completion of the course the student will be able to :

1. Describe the state of stress and strain in 2D and 3D elastic members subjected to direct loads.
2. Analyse the structural members: beam, rotating disks & columns.
3. Compute the torsional rigidity of circular and non-circular sections.
4. Estimate the thermal stresses in circular disks.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module.

TEXT BOOKS:

1. Theory of Elasticity, S. P. Timoshenko and J. N Goodier, Mc. Graw, Hill International, 3rd Ed., 2010.

2. Theory of Elasticity, Dr. Sadhu Singh, Khanna Publications, 2004.

Reference Books:

1. Advanced Mechanics of solids, L. S. Srinath, Tata Mc. Graw Hill,2009.

2. Theory of Elastic stability, Stephen P. Timoshenko, Mc Graw Hill, 2nd Ed, 2014

Course Code	18ME562	Course Title	Smart Materials & Structures	Semester	V
Credits	3	L – T – P –TL*	3 – 0 – 0 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course objectives: This course will enable students to; 1. Study the smart materials, piezoelectric materials and their characteristics. 2. Model & analyze Smart structures & shape memory alloys. 3. Understand the principles and concepts of MEMS, ER & MR Fluids for various applications.	**Teaching Hrs**
Module-1 **Introduction:** Closed loop and Open loop Smart Structures. Applications of Smart structures, Piezoelectric properties. Inchworm Linear motor, Shape memory alloys, Shape memory effect-Application, Processing and characteristics. **Shape Memory Alloys:** Introduction, Phenomenology, Influence of stress on characteristic temperatures, Modelling of shape memory effect. Vibration control through shape memory alloys.	**8**
Module-2 **Electro rheological and Magneto rheological Fluids:** Mechanisms and Properties, Characteristics,Fluid composition and behaviour, Discovery and Early developments, Summary of material properties. Applications of ER and MR fluids (Clutches, Dampers, others). **Fibre Optics:** Introduction, Physical Phenomenon, Characteristics, Fibre optic strain sensors, Twisted and Braided Fibre Optic sensors, Optical fibres as load bearing elements, Crack detection applications, Integration of Fibre optic sensors and shape memory elements.	**8**
Module-3 **Vibration Absorbers:** Introduction, Parallel Damped Vibration Absorber, Analysis, Gyroscopic Vibration absorbers, analysis & experimental set up and observations, Active Vibration absorbers. **Control of Structures:** Introduction, Structures as control plants, Modelling structures for control, Control strategies and Limitations. Biomimetics: Characteristics of Natural structures. Fibre reinforced: organic matrix natural composites, Natural creamers, Mollusks. Biomimetic sensing, Challenges and opportunities.	**10**
Module-4 **Smart Actuators**: Modelling Piezoelectric Actuators, Amplified Piezo Actuation – Internal and External Amplifications, Magnetostrictive Actuation, Joule Effect, Wiedemann Effect, Magneto volume Effect, **Actuators & Controllers**: Magnetostrictive Mini Actuators, IPMC and Polymeric Actuators, Shape Memory Actuators, Active Vibration Control, Active Shape Control, Passive Vibration Control, Hybrid Vibration Control.	**8**

Module-5	
Instrumented structures functions and response – Sensing systems – Self -diagnosis – Signal processing consideration – Actuation systems and effectors. **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**

On completion of the course the student will be able to :

1. Analyze the properties of smart structures, MEMS, with the applications and select suitable procedure for fabrication
2. Explain the principle concepts of Smart materials, structures, fiber optics, ER & MR fluids and MEMS.
3. Describe the methods of controlling vibration using smart systems and functioning of actuators.
4. Summarize the methods and uses of instrumented structures & case studies.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module.

TEXT BOOKS:

1. Smart Structures –Analysis and Design", A.V.Srinivasan, Cambridge University Press, New York, 2001, (ISBN:0521650267).

2. Smart Materials and Structures", M.V.Gandhi and B.S.Thompson Chapmen & Hall, London, 1992 (ISBN:0412370107)

Reference Books:

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

Course Code	18ME563	Course Title	Automation and Robotics	Semester	V
Credits	3	L – T – P –TL*	2 – 1 – 0 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to; • Develop knowledge in different types robots and their working. • Exposed to the basics of sensors, manipulators, actuators and grippers. • Develop skills in knowing automation and material handling systems in industry.	**Teaching Hrs**
Module – 1 **Introduction to Robotics:** Definition and origin of robotics – different types of robotics – various generations of robots – degrees of freedom – Asimov's laws of robotics . **Sensors**; Sensors, analog to digital converters, digital to analog converters, input/output devices for discrete data	**10**
Module – 2 **Power Sources:** Hydraulic, pneumatic and electric drives – determination of HP of motor and gearing ratio – variable speed arrangements – path determination. **Micro machines:** Micro machines in robotics – machine vision – ranging – laser – acoustic – magnetic, fiber optic and tactile sensors.	**8**
Module - 3 **Manipulators, Grippers:** Construction of manipulators – manipulator dynamics and force control – electronic and pneumatic manipulator control circuits – end effectors –various types of grippers. **Robot Actuators**: Position sensors – Potentiometers, resolvers, encoders, velocity sensors. Actuators - Pneumatic and Hydraulic Actuators, Electric Motors, Stepper motors, Servomotors, Power Transmission systems	**8**
Module – 4 **Introduction to Automation** Basic elements of an automated system, advanced automation functions, levels of automation, process industries versus discrete manufacturing industries. **Industrial Automation:** List basic Devices in Automated Systems • Distinguish Different Controllers Employed In Automated Systems. Identify Safety in Industrial Automation	**8**
Module - 5 **Material handling and:** Overview of Material Handling Systems, Principles and Design Consideration, Material Transport Systems, Storage Systems, **Identification Technologies** :Overview of Automatic Identification Methods.	**8**

Course outcomes: After a successful completion of the course, the student will be able to:
CO1:Identify the Joints, Links, Sensors, Control units,
CO2:Explain Manipulators, Actuators, Grippers and elements of Automation
CO3:Describe Material Handling Systems & automation.

Question paper pattern:

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

TEXT BOOKS:

1. Mikell P Groover. Weiss G.M., Nagel R.N., Odraj N.G., Industrial Robotics, McGraw-Hill , Singapore, 1996.
2. Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied 4. Publishers, Chennai, 1998.

REFERENCE BOOKS

1. Deb.S.R., Robotics technology and flexible Automation, John Wiley, USA 1992.
2. Asfahl C.R., Robots and manufacturing Automation, John Wiley, USA 1992.
3. Klafter R.D., Chimielewski T.A., Negin M., Robotic Engineering – An integrated approach, Prentice Hall of India, New Delhi, 1994.
4. Mc Kerrow P.J. Introduction to Robotics, Addison Wesley, USA, 1991. 5. Issac Asimov I Robot, Ballantine Books, New York, 1986.

Course Code	18MEL57	Course Title	FLUID MECHANICS & MACHINERY LAB	Semester	V
Credits	2	L – T – P –TL*	1 – 0 – 2 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to;

1. Understanding of flow measurements using various types of flow measuring devices, calibration and losses associated with these devices.
2. Study the Energy conversion principles, analysis and understanding of hydraulic turbines and pumps.
3. Perform analysis using characteristic curves.

Teaching Hrs

PART – A

1. Lab layout, calibration of instruments and standards to be discussed.
2. Determination of coefficient of friction of flow in a pipe.
3. Determination of minor losses in flow through pipes.
4. Application of momentum equation for determination of coefficient of impact of jets on flat, curved and hemispherical blades
5. Calibration of flow measuring devices: Orifice meter, Venturimeter, Notches.

PART – B

7. Performance on hydraulic Turbines
   a. Pelton Wheel b. Francis Turbine c. Kaplan Turbine.
8. Performance on hydraulic pumps.
   a. Single stage centrifugal pump b. Multi stage centrifugal pump c. Reciprocating pump
9. Performance test on a two stage Reciprocating Air Compressor.

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

CO1: Perform experiments to determine the coefficient of discharge of flow measuring devices.

CO2: Conduct experiments on hydraulic turbines and pumps to draw characteristics.

CO3: Test basic performance parameters of hydraulic turbines and pumps and execute the knowledge in real life situations.

CO4: Determine the energy flow pattern through the hydraulic turbines and pumps.

CO5: Exhibit his competency towards preventive maintenance of hydraulic machines.

Textbooks:

1. K.L.Kumar. "Engineering Fluid Mechanics" Experiments, Eurasia Publishing House, 1997.
2. JagdishLal, "Hydraulic Machines", Metropolitan Book Co, Delhi, 1995.
3. George E. Totten , Victor J. De Negri "Handbook of Hydraulic Fluid Technology", Second Edition, 2011.

Scheme of Examination:

ONE question from part -A: 30 Marks

ONE question from part -B: 50 Marks

Viva -Voice: 20 Marks

Total: 100 Marks (To be reduced to 60 Marks)

Course Code	18MEL58	Course Title	ENERGY LAB	Semester	V
Credits	2	L – T – P –TL*	1 – 0 – 2 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to; **1.** Study the behaviour of lubricating oil, liquid fuels and to plot response curves. **2**. Know the Energy conversion principles, analysis and understanding of I C Engines. **3**. Understand the thermodynamics, combustion, heat transfer, friction and other factors affecting engine power, efficiency and emissions. **4.** Introduce students to future internal combustion engine technology.	**Teaching Hrs**
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 / Cleveland's Apparatus. **3**. Determination of Viscosity of lubricating oil using Redwoods, Saybolt and Torsion Viscometers. **4**. Valve Timing/Port opening diagram of an I.C. Engine. **5**. Analysis of moisture, ash content and fixed carbon of solid and liquid fuel samples. **PART – B** **6.** 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	

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

CO1: Determine the properties of fuels and oils.
CO2: Explain the valve Timing/Port opening diagram of an I.C. Engine.
CO3: Analyze the performance parameters of I.C. Engine.
CO4: Distinguish the operating characteristics of different engines.

Textbooks:

1. John Heywood, Internal combustion engine fundamentals, McGraw- Hill (1988) - USA.
3. M. L. Mathur And R.P. Sharma A course in internal combustion engines, Dhanpat Rai & sons- India
4.

References

1. Richard stone, Introduction to internal combustion engines, MacMillan (1992) – USA
2. C. F. Taylor The internal combustion engines in theory and practice, 2 vols. , Wily.
3. Ganesan, V., Fundamentals of IC Engines, Tata McGraw Hill, 2003

Scheme of Examination:

ONE question from part –A : 30 Marks
ONE question from part -B : 50 Marks
Viva –Voice : 20 Marks
Total : 100 Marks (To be reduced to 60 Marks)

|| Jai Sri Gurudev||

ADICHUNCHANAGIRI UNIVERSITY

BGS Institute of Technology

B. E. Mechanical Engineering

Scheme for Sixth Semester Mechanical Engineering

Sl. No	Course Code	Title of the Course	Teaching Department	Teaching Hours/week				Examination				Credits
				L	T	P	TL	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
1	18ME61	Computer integrated Manufacturing	ME	2	1	0	3	3	40	60	100	3
2	18ME62	Finite Element Methods	ME	4	1	0	5	3	40	60	100	4
3	18ME63	Heat Transfer	ME	3	1	0	4	3	40	60	100	3
4	18ME64	Machine Design-II	ME	4	1	0	5	3	40	60	100	4
Professional Elective-– 3												
5	18ME651	Flexible Manufacturing System	ME	3	0	0	3	3	40	60	100	3
	18ME652	Automobile Engineering	ME	3	0	0	3	3	40	60	100	3
	18ME653	Power Plant Engineering	ME	3	0	0	3	3	40	60	100	3
Professional Elective-– 4												
6	18ME661	Theory of Plasticity	ME	3	0	0	3	3	40	60	100	3
	18ME662	Total Quality Management	ME	3	0	0	3	3	40	60	100	3
	18ME663	Mechanical Vibrations	ME	3	0	0	3	3	40	60	100	3
7	18MEL67	Heat Transfer Lab	ME	1	0	2	3	3	40	60	100	2
8	18MEL68	CAMA Lab	ME	1	0	2	3	3	40	60	100	2
9	18SSD60	Soft Skill Development-4	HRD	0	2	0	2	1	30	20	50	1
10	18Sports 69	Sports	PED	--	--	1	1	--	50	--	50	0
TOTAL CREDITS & CONTACT HOURS							**32**		**400**	**500**	**900**	**25**
TOTAL CREDITS OF I SEMESTER TO VI SEMESTER				(I Sem + II Sem+III Sem+IV Sem+V Sem) 24+24+25+25+26= 124								**149**

Course Code	18ME61	Course Title	Computer integrated Manufacturing	Semester	VI
Credits	3	L – T – P –TL*	2 – 1 – 0 – 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to: • Impart knowledge of CIM and Automation and different concepts of automation by developing mathematical models. • 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. • Expose to automated flow lines, assembly lines, Line Balancing Techniques, and Flexible Manufacturing Systems. • Exhibit to computer aided process planning, material requirement planning, capacity planning etc. • Expose to CNC Machine Tools, CNC part programming, and industrial robots.	**Teaching Hrs**
Module-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. **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.	**10**
Module-2 **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. **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.	**8**

Module-3 **Flexible Manufacturing Systems:** Fundamentals of Group Technology and Flexible Manufacturing Systems, types of FMS, FMS components, Material handling and storage system, applications, benefits, computer control systems, FMS planning and design issues, Automated Storage and Retrieval Systems. **Line Balancing:** Line balancing algorithms, methods of line balancing, numerical problems on largest candidate rule, Kilbridge and Wester method, and Ranked Positional Weights method.	**8**
Module-4 **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, programming with canned cycles. Cutter radius compensations. **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	**8**
Module-5 **Additive Manufacturing Systems:** Basic principles of additive manufacturing, slicing CAD models for AM, advantages and limitations of AM technologies, Additive manufacturing processes: Photo polymerization, material jetting, binder jetting, material extrusion, Powder bed sintering techniques, sheet lamination, direct energy deposition techniques, applications of AM. Recent trends in manufacturing, Hybrid manufacturing. **Future of Automated Factory:** Industry 4.0, functions, applications and benefits. Components of Industry 4.0, Internet of Things (IOT), IOT applications in manufacturing, Big-Data and Cloud Computing for IOT, IOT for smart manufacturing, influence of IOT on predictive maintenance, industrial automation, supply chain optimization, supply-chain & logistics, cyber-physical manufacturing systems.	**8**
Course outcomes: By the end of the course the students can able to: CO1: Define CIM and Automation and different concepts of automation by developing mathematical models. CO2: Explain automated flow lines, assembly lines, Line Balancing Techniques, and Flexible Manufacturing Systems. CO3: Analyze computer aided process planning, material requirement planning, capacity planning etc. CO4: Explain CNC Machine Tools, CNC part programming, and industrial robots. CO5: Visualize and appreciate the modern trends in Manufacturing like Additive Manufacturing, Internet of Things, and Industry 4.0 leading to Smart Factory.	
Question paper pattern: • The question paper will have ten full questions carrying equal marks. • Each full question will be for 20 marks. • There will be two full questions (with a maximum of four sub- questions) from each module. • Each full question will have sub- question covering all the topics under a module. The students will have to answer five full questions, selecting one full question from each module.	

Textbooks:

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. Computer Integrated Manufacturing, J. A. Rehg& Henry. W. Kraebber.
2. CAD/CAM by Zeid, Tata McGraw Hill.

Course Code	18ME62	Course Title	Finite Element Method	Semester	VI
Credits	4	L – T – P –TL*	4– 0 – 0 – 4	Teaching Hrs	56
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to: • Understand the Mathematical and physical principles underlying the Finite Element Method (FEM). • Know the comprehensive knowledge of basics of Finite element method as an analysis tool. • Learn the characteristics of various elements and selection of materials. • Derive finite element equations for simple and complex elements of Bar, Truss, 2-D, Beams and 1-D Heat Transfer problems. •	**Teaching, Hrs**
Module-1 **Introduction:** Review of Matrices, Types, operations, properties, Gauss Elimination Algorithm to solve set of Simultaneous Equations. Principle of Minimum Potential Energy, Euler Lagrange equation, Ray-Leigh Ritz method, Galakin's method. **Basics of Elasticity:** Stress and Strain equations, strain - displacement relations, stress-strain relations, plane stress, plane strain, potential energy and equilibrium. Basic equation of elasticity, their relationship and equilibrium equations in elasticity subjected to body force, traction forces and point loads, concept of plane stress and plane strain.	**12**
Module-2 **Introduction:** Definition of finite element, Node, Node Numbering, Types of Elements, 1-D,2-D,3-D elements, local and global co-ordinate system, One-dimensional Finite element modeling, coordinates and shape functions-Interpolation polynomials-Linear, quadratic and cubic, strain displacement matrix, assembly of the global stiffness matrix and load vector, treatment of boundary conditions- Steps involved in FEM. **Solution of 1-D Bars**: Solutions of bars and stepped bars for displacements, reactions and stresses by using penalty approach and elimination approach. Gauss-elimination technique.	**12**
Module-3 **Trusses**: Plane trusses, local and global co-ordinate system, direction cosines, Transformation matrix, elemental stiffness matrix, force vectors, Global stiffness matrix and load vectors, calculation of Nodal displacements, stresses and Reactions. **Numerical Integration**: Gauss quadrature, one, two and three point integrals.	**10**

Module-4 **Higher Order Elements:** Lagrange's interpolation Models: Interpolation polynomials- Linear, quadratic and cubic. Simplex, complex and multiplex elements.2D PASCAL's triangle. CST elements-Shape functions and Nodal load vector, Strain displacement matrix and Jacobian for triangular element. **Quadrilateral Elements**: Two-dimensional Isoparametric Elements, Four-node, 8-Node and 9-node quadrilateral element, shape functions.	**12**
Module-5 **Beams**: Hermite shape functions for beam element, Derivation of stiffness matrix. Numerical problems of beams carrying concentrated, UDL and linearly varying loads. **Heat Transfer**: Steady state heat transfer, 1D heat conduction governing equations. Functional approach for heat conduction. Galerkin's approach for heat conduction.	**10**

Course outcomes: By the end of the course the student shall be able to:

CO1:Apply the principle of minimum potential energy for solving Analytical Problems

CO2:Analyze 1-D ,2-D and 3-D problems using Finite Element Procedure

CO3: Compute shape function, Global Stiffness matrix, load vector and form Equilibrium equations.

CO4: Solve truss and Beam problems using elimination approach.

CO5: Apply FEM method to solve 1D Steady State Heat Transfer Problems.

Question paper pattern:

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

Text Books:

1. Tirupathi R. Chandrupatla, Ashok D. Belegundu, Introduction to Finite Elements in Engineering, 3/e, Pearson Education, 2009.
2. Finite Element Analysis, S.S. Bhavikatti, New Age International publishers,2006.

Reference Books:

1. S.S.Rao, Finite Element Method in Engineering, Elsevier Butterworth Heinmenn Publications, 2013.
2. J.N. Reddy, An Introduction to the Finite Element Method, 3/e, McGraw Hill Publications, 2018.
3. Robert D. Cook, David S. Malkus, Michael E. Plesha, Rober J. Witt, Concepts and Applications of Finite Element Analysis, 4/e, Wiley India 2019.

Course Code	18ME63	Course Title	Heat Transfer	Semester	VI
Credits	3	L – T – P –TL*	2 – 1 – 0 – 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to: • 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	**Teaching, Hrs**
Module-1 **Introduction:** Modes of heat transfer, Basic laws governing conduction, convection and radiation heat transfer. Conduction- Basic Engineering: Derivation of general form heat conduction equation in rectangular coordinates, heat conduction equation in cylindrical and spherical coordinates (no derivation). Boundary conditions of 1st, 2nd and 3rd kind. **Conduction**: One dimensional heat conduction equations in rectangular, cylindrical and spherical coordinates with and without internal heat generation, Thermal contact resistance, Composite wall, overall heat transfer coefficient Numerical.	**10**
Module-2 **Critical thickness of insulation:** Critical radius for Cylinder and Sphere, Heat transfer in extended surface of uniform cross section without heat generation, Long fin, short fin with tip insulated and without tip insulated and fin with specified end temperatures. Fin efficiency and effectiveness. Numerical problems. **One-Dimensional Transient Conduction:** Conduction in solids with negligible internal temperature gradient (Lumped system analysis), Use of Transient temperature charts (Heisler's charts) for transient conduction in slab, long cylinder and sphere; use of transient temperature charts for transient conduction in semi-infinite solids. Numerical.	**8**
Module-3 **Free Or Natural Convection:** Application of dimensional analysis for free convection- physical significance of Grashoff number; use of correlations of free convection in vertical, horizontal and inclined flat plates, vertical and horizontal cylinders and spheres, Numerical.	**8**

Forced Convection: 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.	
Module-4 **Heat Exchanger:** Classification of heat exchangers; overall heat transfer coefficient, fouling and fouling factor; LMTD, Effectiveness-NTU methods of analysis of heat exchangers. Numerical. **Condensation:** 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. Numerical.	**8**
Module-5 **Thermal radiation:** Definitions of various terms used in radiation heat transfer; Stefan-Boltzman law, Kirchoff's law, Planck's law Rayleigh-Jeans' 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.	**8**
Course outcomes: By the end of the course the students should be able to: CO1: Apply the principles and operations of Turbo-machines and the use of velocity triangles. CO2: Analyze the energy transfer in Turbo machine with degree of reaction and utilization factor. CO3: Classify, analyze the various types of steam turbine. CO4: Apply basics of fluid machines of hydraulic turbines. CO5: Evaluate the performance parameters of pumps with the use of velocity triangles.	
Question paper pattern: • The question paper will have ten full questions carrying equal marks. • Each full question will be for 20 marks. • There will be two full questions (with a maximum of four sub- questions) from each module. • Each full question will have sub- question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module.	
Textbooks: 1. Principals of heat transfer,FrankKreith, Raj M. Manglik, Mark S. Bohn, Seventh Edition, Cengage learning, 2011. 2. Yunus A. Cengel - Heat transfer, a practical approach, Fifth edition,Tata Mc Graw Hill. 3. J P Holman, Souvik Bhattacharyya, 10th Edition, McGraw Hill Education Private Ltd., **Reference Books:** 1. Heat and mass transfer, Kurt C, Rolle, second edition, Cengage learning. 2. Heat Transfer, M. NecatiOzisik, A Basic Approach, McGraw Hill, New York, 2005. 3. Fundamentals of Heat and Mass Transfer, Incropera, F. P. and De Witt, D. P., 5th Edition, John Wiley and Sons, New York, 2006. 4. Heat Transfer, Holman, J. P., 9th Edition, Tata McGraw Hill, New York, 2008.	

Course Code	18ME64	Course Title	Machine Design-II	Semester	VI
Credits	4	L – T – P –TL*	4 – 1 – 0 – 5	Teaching Hrs	56
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to: • Select transmission elements like gears, belts, pulleys, bearings from the manufacturers' catalogue. • Design completely a mechanical system integrating machine elements. • Produce assembly and working drawings of various mechanical systems involving machine elements like belts, pulleys, gears, springs, bearings, clutches and brakes.	**Teaching Hrs**
Module-1 **Introduction Curved Beams**: Winkler - Bach equation, Stresses in curved beams of standard cross sections used in crane hook, Punching presses and clamps. **Springs:** Types of springs - Stresses in coiled springs of circular and non-circular cross sections and concentric springs. Springs under fluctuating loads, Leaf and carriage springs. Stress in Leaf springs. Torsion, Belleville and Rubber springs.	**12**
Module-2 **Gear drives:** Classification of gears, materials for gears, standard systems of gear tooth, lubrication of gears, and gear tooth failure modes. **Spur Gears:** Definitions, stresses in gear tooth: Lewis equation and form factor, design for strength, dynamic load and wear. Helical Gears: Definitions, transverse and normal module, formative number of teeth, design based on strength, dynamic load and wear.	**12**
Module-3 **Bevel Gears:** Definitions, formative number of teeth, design based on strength, dynamic load and wear. **Worm Gears:** Definitions, types of worm and worm gears, and materials for worm and worm wheel. Design based on strength, dynamic, wear loads and efficiency of worm gear drives.	**10**
Module-4 **Design of Clutches:** Necessity of a clutch in automobile, types of clutch, friction materials and its properties. Design of single plate, multi-plate and cone clutches based on uniform pressure and uniform wear theories. **Design of Brakes:** Different types of brakes, Concept of self-energizing and self-locking of brakes. Practical examples, Design of band brakes, block brakes and internal expanding brakes.	**10**

Module-5	
Lubrication and Bearings: Lubricants and their properties, bearing materials and properties; mechanisms of lubrication, hydrodynamic lubrication, pressure development in oil film, bearing modulus, coefficient of friction, minimum oil film thickness, heat generated, and heat dissipated. Numerical examples on hydrodynamic journal and thrust bearing design. **Antifriction bearings:** Types of rolling contact bearings and their applications, static and dynamic load carrying capacities, equivalent bearing load, load life relationship; selection of deep grove ball bearings from the manufacturers‟ catalogue; selection of bearings subjected to cyclic loads and speeds; probability of survival.	**12**

Course outcomes: After a successful completion of the course, the student will be able to:
CO1: Design curved beams & springs for different applications
CO2: Design spur, helical, bevel and worm gears from strength; wear considerations using standard practices and standard data
CO3: Design the brakes and clutches for different applications.
CO4: Design journal bearings, ball and roller bearing use standard practices and standard data to design/select them.

Question paper pattern:

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

Text Book:

1.Maleev & Hartman's, Machine Design in SI units, 5th Edition, C B S Publications, Delhi, 2005.ISBN:9788123906379

Reference Books:

1. Joseph Edward Shigley, Mechanical Engineering Design, Mc. Graw Hill, 8th Edition, 2008. ISBN:9780073529288.
2. V.B.Bhandari, Design of Machine Elements, TMH, 3rd Edition2007.ISBN: 9780070681748.

Design Data Hand Books:

1. K. Mahadevan and Balaveera Reddy, Design Data Hand Book, C B S Publications, Delhi. ISBN:9788123901626.
2. Design Data Hand Book, K. Lingaiah, McGraw Hill, 2nd edition, 2003.

Course Code	18ME651	Course Title	Flexible Manufacturing System	Semester	VI
Credits	3	L – T – P –TL*	2 – 1 – 0 – 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course objectives: This course will enable students to: • Understand the need for flexibility in manufacturing industries. • Learn the development and implementation of an FMS. • Learn the different types of automated material handling systems its design and calculations for different applications both AS/RS.	**Teaching Hrs**
Module-1 **Introduction**: Flexible and rigid manufacturing, F.M. Cell and F.M. System concept, Types and components of FMS, Tests of flexibility, Group Technology and FMS, unmanned factories, Economic and Social aspects of FMS. **AS/RS:** Material handling and storage system, Advanced material handling systems, automated guided vehicle systems, Automated Storage and Retrieval Systems, applications, benefits.	**8**
Module-2 **Control structure of FMS:** Architecture of typical FMS, Automated work piece flow, Control system architecture – Factory level, Cell level; hierarchical control system for FMS. **LANs:** characteristics, transmission medium, signalling, network topology, access control methods; Factory networks, Structure and functions of manufacturing cell, Distributed Numerical Control (DNC).	**8**
Module-3 **Scheduling of FMS:** Introduction, Scheduling of operations on a single machine, 2 machine flow shop scheduling, 2 machine job shop scheduling, 3 machine flow shop scheduling, scheduling 'n' operations on 'n' machines, Scheduling rules. **Loading of FMS:** Loading problems, Tool management of FMS, material Handling system schedule. Problems.	**8**
Module-4 **Tooling in FMS:** Modern cutting tools and tool materials, tool holders, modular tooling, tool monitoring, presetting and offsets, wear and radius compensation, tool magazines, automatic tool changers, robotized tool assembly, tool management system . **Simulation and Data Base:** Application of simulation-model of FMS, Simulation software, limitations, manufacturing data systems, data flow, FMS data base systems, Planning for FMS database.	**8**
Module-5 **Fixturing in FMS:** Part holding on Pallets, standard fixtures, pallet changers, pallet pool, flexible fixturing – principles and methodologies.	**10**

Modular fixturing system: T slot based, dowel pin based, fixturing components, computer aided fixture design – locating and clamping, use of GT in fixture design, fixture database.	

Course outcomes: By the end of the course the students can able to:

CO1: Get a clear idea of importance of an FMS system in present manufacturing world.
CO2: Explain the different types of FMS layouts, material handling and retrieval systems.
CO3: Solve the sequencing problems for different cases and tool management.
CO4: Design and analyze FMS using simulation software.

Question paper pattern:

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

Textbooks:

1. Groover, Mikell P. (2002), 2/e, " Automation, Production Systems & Computer Integrated Manufacturing", Pearson Education or PHI
2. Viswanadhan, N. & Narahari, Y. (1998), "Performance Modelling of Automated Manufacturing Systems", PHI
3. Pinedo, Michael & Chao, Xiuly (1999), "Operations Scheduling with Applications in Manufacturing & Services", McGraw Hill International Editions (with 2 Floppy Disks of LEKIN Scheduling Software).

Reference Books:

1. Radhakrishnan, Subramanyan, "CAD / CAM / CIM", John Wiley
2. Rao, PN, Tewari NK, Kundra TK, "Computer Aided Manufacturing", TMH.

Course Code	18ME652	Course Title	Automobile Engineering	Semester	VI
Credits	3	L – T – P –TL*	2 – 1 – 0 – 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to: • Broaden the understanding of students in the structure of vehicle chassis and engines. • Introduce students to steering, suspension, braking and transmission systems. • Introduce students to engine auxiliary systems like heating, ventilation and air-conditioning. • Teach students about the importance of alternate fuels and modifying the engine suitably.	**Teaching Hrs**
Module – 1 **Engine Components:** Basic components of engine components, importance with reference to application valve timing diagrams for SI engine and CI engine, Types of combustion chambers for S.I. Engine and C.I. Engines, methods of a Swirl generation, engine positioning, cooling requirements, methods of cooling and lubrication. **Fuels, Fuel Supply Systems For Si Engines:** Conventional fuels, alternative fuels, Combustion in S I and C I engines, normal and abnormal combustion, Knocking and detonation, cetane and octane numbers, Fuel mixture requirements for SI engines.	**12**
Module – 2 **Fuel Supply System:** Carburetor-construction and working of simple carburetor, multi point and single point fuel injection systems. Fuel transfer pumps, Fuel filters, fuel injection pumps and injectors. Fuel injection system in CI engines, CRDI System. **Superchargers and Turbochargers:** Naturally aspirated engines, Forced Induction, Types of superchargers, Turbocharger construction and operation, Intercooler. **Ignition Systems:** Battery Ignition systems, magneto Ignition system, Electronic Ignition system, Ignition advance.	**10**
Module – 3 **Power Trains:** General arrangement of clutch, Principle of friction clutches, Fluid flywheel, and Single plate, multi-plate and centrifugal clutches. **Gear Box:** Necessity for gear ratios in transmission, synchromesh gear boxes, 3, 4 and 5 speed gear boxes. Freewheeling mechanism, planetary gears systems, over drives, fluid coupling and torque converters, Epicyclic gear box, principle of automatic transmission,	**10**
Module – 4 **Drive to Wheels:** Propeller shaft and universal joints, Hotchkiss and torque tube drives, differential, rear axle,	**10**

different arrangements of fixing the wheels to rear axle, steering geometry, camber, king pin inclination, included angle, castor, toe in & toe out, steering gears, power steering, general arrangements of links and stub axle, over steer, under steer and neutral steer **Suspension System and Brakes:** Requirements, Torsion bar suspension systems, leaf spring, coil spring, independent suspension for front wheel and rear wheel. Air suspension system.	
Module – 5 **Brakes**: - Brakes and its mechanism, Disk brakes, drum brakes, Antilock –Braking systems, purpose and operation of antilock-braking system, ABS Hydraulic Unit. **Engine Emissions and Standards:-** S I Engine emissions and C I Engine emissions, emission controls, Controlling the air-fuel mixture, Controlling the combustion process, Cleaning the exhaust gas, Exhaust gas recirculation, Catalytic converter, Brief discussion on Emission standards- Euro I, II, III and IV norms, Bharat Stage II, III and IV norms.	**10**

Course Outcomes: After a successful completion of the course, the student will be able to:

CO1: Identify The Different Parts Of An Automobile And It's Working
CO2: Understand the working of transmission and braking systems
CO3: Comprehend the working of steering and suspension systems
CO4: Learn various types of fuels and injection systems
CO5: Know the cause of automobile emissions, its effects on environment and methods to reduce the emissions.

Question Paper Pattern:

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

Text Books:

1. William.H.Crouse, (2006), Automotive Mechanics, 10th Edition, McGraw-Hill.
2. Kirpal Singh, Automobile Engineering, Vol.1&2, Standard Publications.
3. Mathur and Sharma Automobile Engineering.

Reference Books:

1. Automotive mechanics, William H Crouse & Donald L Anglin (10th Edition) Tata McGraw Hill Publishing Company Ltd., 2007
2. Automotive mechanics: Principles and Practices, Joseph Heitner, D Van Nostrand Company, Inc Fundamentals of Automobile Engineering, K.K.Ramalingam, Scitech Publications (India) Pvt. Ltd.
3. Automobile Engineering, R. B. Gupta, Satya Prakashan,(4th Edition) 1984.

Course Code	18ME653	Course Title	Power Plant Engineering	Semester	VI
Credits	3	L – T – P –TL*	3 – 0 – 0 – 3	Teaching Hrs	42
Total Marks	100	SEE*	60	CIE*	40

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to: • Explore various methods of power generation using various resources. • Understand working principle of different types of boilers and their accessories. • Describe the benefits and limitations of various types of power plants. • Analyze the cost effectiveness with regard to power plant conception to application.	**Teaching Hrs**
Module - 1 **Steam Power Plant**: 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. **Furnaces and Boilers**: Pulverized fuel furnaces, cyclone furnace, Coal and ash handling, Generation of steam using forced circulation, high and supercritical pressures, A brief account of La Mont, Benson, Velox, Loeffer and Ramson steam generators.	**10**
Module – 2 **Chimneys:** Natural, forced, induced and balanced draft, Calculations involving height of chimney to produce a given draft. **Accessories**: Accessories for the Steam Generator such as super-heaters desuperheater control of super heaters, Economizers, Air Pre- heaters and re-heaters. Cooling Towers and Ponds: Different types of towers.	**8**
Module – 3 **Hydro-Electric Plants**: Storage and pondage, flow duration and mass curves, hydrographs, low, medium and high head plants, pumped storage plants, Penstock, water hammer, surge tanks, gates and valves, power house, general layout. A brief description of some of the important Hydel installations in India. **Nuclear Power Plant**: Principles of release of nuclear energy, Fusion and fission reactions. Elements of the Nuclear reactor- Moderator, control rod, fuel rods, coolants. Brief description of reactors - Pressurized water reactor (PWR), Sodium graphite reactor, Radiation hazards, Radio-active waste disposal.	**8**

Module – 4 **Diesel Engine Plant** -Engines for Power Generation: Method of starting diesel engines, Cooling and lubrication system for the diesel engine. Filters, centrifuges, Oil heaters, Intake and exhaust system, Layout of a diesel power plant. **Gas Turbine Power Plant**: Advantages and disadvantages of the gas turbine plant Open and closed cycle turbine plants with the accessories.	**8**
Module – 5 **Choice of Site for Power Station**: load estimation, load duration curve, load factor, capacity factor, use factor, diversity factor, and demand factor, Effect of variable load on power plant, selection of the number and size of units. **Economic Analysis of Power Plant:** Cost of energy production, selection of plant and generating equipment, performance and operating characteristics of power plants.	**8**
Course Outcomes: By the end of the course the students should be able to: CO1: Discuss the working principle of the power plant. CO2: Describe the particular methods to be used in power plant. CO3: Identify the benefits and limitations of working processes used in the power plant. CO4: Evaluate the economic analysis of various power plants.	
Question paper pattern: • The question paper will have ten full questions carrying equal marks. • Each full question will be for 20 marks. • There will be two full questions (with a maximum of four sub- questions) from each module. • Each full question will have sub- question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module.	
Textbooks: 1. P.K Nag, **"Power Plant Engineering"**, 3rd Ed. Tata McGraw Hill 2001. 2. Arora and Domkundwar, "**Power Plant Engineering"**, 8th Ed. Dhanpat Rai & Co. **Reference Books:** 1. M M Ei Wakil, **"Power Plant Technolgy"**, Tata McGraw Hill. 2. R.K Hegde, **"Power Plant Engineering"** Pearson, 2014.	

Course Code	18ME661	Course Title	Theory of Plasticity	Semester	VI
Credits	3	L – T – P –TL*	3 – 0 – 0 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course objectives: This course will enable students to: • Introduce the concepts of Plasticity and mechanism of Plastic deformation in metals. • Expose the students to elasto-plastic problems involving plastic deformation of beams and bars. • Introduce the concepts of slip line field theory.	**Teaching Hrs**
Module-1 **Analysis of Stress:** Definition and notation of stress, equations of equilibrium in differential form, stress components on an arbitrary plane, equality of cross shear, stress invariants, **Principal stresses:** Principal stresses octahedral stress, planes of maximum shear, stress transformation, plane state of stress, Numerical.	**8**
Module-2 **Analysis of Strain:** Displacement field, strains in term of displacement field, infinitesimal strain at a point, engineering shear strains, strain invariants, **Principal strain:** Principal strains, octahedral strains, plane state of strain, compatibility equations, strain transformation, Numerical.	**8**
Module-3 **Two-Dimensional classical elasticity Problems:** Cartesian co-ordinates - Relation between plane stress and plane strain, stress functions for plane stress and plane strain state, Airy's stress functions, Investigation of Airy's stress function for simple beams, bending of a narrow cantilever beam of rectangular cross section under edge load. Bending of simply supported beam under UDL. **Polar Co-ordinates:** General equations in polar coordinates, stress distribution symmetrical about an axis, Thick wall cylinder subjected to internal and external pressures, Numerical.	**10**
Module-4 **Axi-symmetric elements:** Stresses in rotating discs of uniform thickness and cylinders. Torsion of circular, elliptical and triangular bars, **Torsion Elements:** Prandtl's membrane analogy, torsion of thin walled thin tubes, torsion of thin walled multiple cell closed sections. Numerical	**8**
Module-5 **Thermal Stresses:** Thermo elastic stress strain relations, equations of equilibrium, thermal stresses in thin	**8**

circular discs and in long circular cylinders. **Columns:** Euler's column buckling load: clamped-free, clamped-hinged, clamped-clamped and pin-ended, Numerical	

Course Outcomes: By the end of the course the students should be able to:

CO1: Describe the state of stress and strain in 2D and 3D elastic members subjected to direct loads.

CO2: Analyze the structural members: beam, rotating disks & columns.

CO3: Compute the torsional rigidity of circular and non-circular sections.

CO4: Estimate the thermal stresses in circular disks.

Question paper pattern:

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

Text Book:

1. R.A.C. Slater, "Engineering Plasticity: Theory and Application to Metal Forming Process," McMillan Press Ltd., 12th March 2011, ISBN: 9780333157091.

2. Sadhu Singh, "Theory of Plasticity and Metal Forming Process," Khanna Publishers, Delhi, 3rd Edition, 2003, ISBN: 9788174090508.

Reference Books:

1. William Johnson and Peter Bassindale Mellor, "Plasticity for Mechanical Engineers," Van Nostrand Publisher, 1966.

2. Chakraborty, "Theory of plasticity," Butter-Heinemann Publisher, 3rd Edition, 2nd May 2006, ISBN: 978-0750666381.

3. Jacob Lubliner, "Plasticity Theory," Dover publications Inc. 25th April 2008, ISBN: 978-0486462905.

4 .L.M. Kachnov, "Fundamentals of the Theory of Plasticity," Courier Corporation, 2004, ISBN: 9780486435831.

Course Code	18ME662	Course Title	Total Quality Management	Semester	VI
Credits	3	L – T – P –TL*	3 – 0 – 0 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course objectives: This course will enable students to: • 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.	**Teaching Hrs**
Module-1 **Principles and Practice**: Definition, basic approaches, Gurus of TQM, TQM Framework, awareness, defining quality, historical review, obstacles, benefits of TQM. Quality Management Systems. **Introduction ISO:** Benefits of ISO registration, ISO 9000 series of standards, ISO 9001 requirements.	**8**
Module-2 **Leadership**: Definition, characteristics of quality leaders, leadership concept, characteristics of effective people, ethics, the Deming's philosophy, **Role of TQM leaders**: Implementation, core values, concepts and framework, strategic planning communication, decision making.	**8**
Module-3 **Customer Satisfaction and Customer Involvement**: Customer Satisfaction, customer and customer perception of quality, feedback, using customer complaints, service quality, translating needs into requirements, customer retention, case studies. Employee Involvement. **Motivation**: Employee surveys, Empowerment, Teams, Suggestion system, recognition and reward, gain sharing, performance appraisal, unions and employee involvement, case studies.	**10**
Module-4 **Continuous Process Improvement**: Juran trilogy, improvement strategies, types of problems, PDSA Cycle, problem-solving methods, Kaizen, reengineering, six sigma, case studies. **Statistical Process Control**: Pareto diagram, process flow diagram, cause and effect diagram, check sheets, Histograms, statistical fundamentals, Control charts, control charts for variables, control charts for attributes, scatter diagrams, case studies.	**8**
Module-5 **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.	**8**
Course Outcomes: By the end of the course the students should be able to: CO1: Explain the various approaches of TQM. CO2: Infer the customer perception of quality. CO3: Analyze customer needs and perceptions to design feedback systems. CO4: Apply statistical tools for continuous improvement of systems. CO5: Apply the tools and technique for effective implementation of TQM.	
Question paper pattern: • The question paper will have ten full questions carrying equal marks. • Each full question will be for 20 marks. • There will be two full questions (with a maximum of four sub- questions) from each module. • Each full question will have sub- question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module.	
Text Books: 1.Total Quality Management, Dale H. Besterfield, Pearson Education India, Edition 03. ISBN: 8129702606. 2. Total Quality Management for Engineers, M. Zairi, Wood head Publishing, ISBN:1855730243.	
Reference Books : 1. Managing for Quality and Performance Excellence, James R. Evans and William M Lindsay, Cengage Learning, 9th edition. 2. Organizational Excellence through TQM, H. Lal, New age Publications, 2008. 3. Introduction to Operations Research- Concepts and Cases, F.S. Hillier. G.J. Lieberman, Tata McGraw Hill, 9 th Edition, 2010.	

Course Code	18ME663	Course Title	Mechanical Vibrations	Semester	V
Credits	3	L – T – P –TL*	2 – 1 – 0 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to: • Understand the theoretical principles of vibration and vibration analysis techniques for the practical solution of vibration problems. • Understand the importance of vibrations in mechanical design of machine parts subject to vibrations.	**Teaching Hrs**
Module – 1 **Introduction**- Types of vibrations, Definitions, Simple Harmonic Motion (S.H.M), Work done by harmonic force, Principle of super position applied to Simple Harmonic Motion. Beats, Numerical. **Undamped (single Degree Of Freedom) Free Vibrations**: Derivations for spring mass system, Methods of Analysis, Natural Frequencies of simple systems. Springs in series and parallel Effects of mass of spring and Numerical.	**10**
Module – 2 **Damped Free Vibrations (1 DOF)**: Type of Damping, Analysis with viscous damping- Derivations For over, critical and under damped systems, Logarithmic decrement and Numerical. **Vibration measuring instruments and whirling of shafts:** seismic instruments, vibrometers, accelerometer, frequency measuring instruments and numerical. Whirling of shafts with and without damping, Discussion of speeds above and below critical speed.	**8**
Module - 3 **Forced Vibrations (1 DOF)**: Introduction, Analysis of forced vibration with constant harmonic excitation – magnification factor, rotating and reciprocating unbalances, excitation of support (relative and absolute amplitudes), force and motion transmissibility, Energy dissipated due to damping and problems. **Modal Analysis:** Condition Monitoring, Dynamic testing of Machines and Structures, Experimental Modal Analysis, Machine condition monitoring and diagnosis.	**8**
Module – 4 **Vibration and Noise Control**: Basics of Noise, Introduction, Amplitude, Frequency, Wave Length and sound pressure level, addition, subtraction and averaging decibel; levels, noise dose level, legislation, **Measurement And Analysis Of Noise:** Measurement Environment, Equipment, Frequency analysis, tracking analysis, sound quality analysis.	**8**
Module - 5 **Numerical methods for multi DOF systems:** Introduction, Maxwell's reciprocal theorem, influence coefficients,	**8**

Rayleigh's method, Dunkerley's method, Stodola method, orthogonality principle, method of matrix iteration and Numerical. **Continuous Systems:** Vibration of string, longitudinal vibration of rods, Torsional vibration of rods, Euler's equation for beams.	

Course outcomes: By the end of the course the student shall be able to:

CO1: Understand and characterize the single and multi degrees of freedom systems subjected to free and forced vibrations with and without damping.

CO2: Understand the method of vibration measurements and its controlling.

CO3: Understand the concept of dynamic vibrations of continuous systems.

Question paper pattern:

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

Text Books:

1. "Theory of Vibration with Application" - William T. Thomson, Marie Dillon Dahleh, Chandramouli Padmanabhan, 5th edition Pearson Education.
2. "Mechanical Vibrations", V. P. Singh, Dhanpat-Rai &Company.

Reference Books:

1. S. Graham Kelly, "Mechanical Vibrations", Schaum's Outlines, Tata Mc GrawHill.
2. C Sujatha, "Vibraitons and Acoustics – Measurements and signal analysis", Tata Mc GrawHill.
3. G. K. Grover "Mechanical Vibrations", Nem Chand and Bros, 2015

Course Code	18MEL67	Course Title	Heat Transfer Lab	Semester	VI
Credits	2	L – T – P –TL*	1 – 0 – 2 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to:

- To provide the students with the necessary skills to conduct experiments on conduction & convection of heat : collect data, perform analysis & interpret results to draw valid conclusions through standard test procedures.
- To determine thermal properties & Performance of Radiation Heat Transfer, Heat Exchanger, Vapor Compression Refrigerator & Air Conditioner.

Teaching Hrs

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 a free Convection on a vertical tube.
5. Determination of Heat Transfer Coefficient in a Forced Convention Flow through a Pipe.
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 Vapour Compression Refrigeration.
5. Performance Test on Vapour Compression Air - Conditioner
6. Experiment on Transient Conduction Heat Transfer

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

CO1. Illustrate the principles of heat and mass transfer pertaining to engineering problems.

CO2.Apply knowledge of heat transfer processes and techniques for solving engineering problems.

CO3.Analyze the principles of heat transfer methods, techniques and technological advances related to thermal engineering applications.

CO4.Create awareness about the relevance of heat transfer for modern engineering applications.

Textbooks:

1. Heat & Mass transfer- Dixit/ Mc Graw Hill
2. Heat & Mass transfer/ Altamush Siddiqui/ Cengage

Reference Books:

1. Essential Heat Transfer_ Christopher A Long/ Pearson
2. Heat Transfer- Ghoshdastida/ Oxford

Scheme of Examination:

ONE question from part -A: 30 Marks

ONE question from part -B: 50 Marks

Viva -Voice: 20 Marks

Total: 100 Marks (To be reduced to 60 Marks)

Course Code	18MEL68	Course Title	CAMA Lab	Semester	VI
Credits	2	L – T – P –TL*	1 – 0 – 2 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to:

- Acquire basic understanding of Modeling and Analysis software
- Understand the concepts of different types of loading on bars, trusses and beams,
- Analyze the results for deformations, stresses and reactions.
- Learn to apply the basic principles to carry out dynamic analysis to know the natural frequencies.

Teaching Hrs

PART – A

Study of a FEA package , modeling analysis of deformations, stresses and reactions:

a. Bars of uniform cross sectional area, tapered cross section area and stepped bar

b. Plane Trusses – (Minimum 2 exercises of different types)

c. Beams – Simply supported, cantilever beams with point load , UDL, UVL with couple. (Minimum 6 exercises)

d. Rectangular plate with a circular hole.

PART – B

Thermal Analysis :

1D & 2D problem with conduction and convection boundary conditions (Minimum 4 exercises of different types)

Dynamic Analysis to find:

a) Natural frequency of beam with fixed – fixed end condition

b) Response of beam with fixed – fixed end conditions subjected to forcing function

c) Response of Bar subjected to forcing functions

PART – C (only for DEMO)

a. Demonstrate the use of graphics standards (IGES, STEP etc) to import the model from modeler to solver.

b. Demonstrate one example of contact analysis to learn the procedure to carry out contact analysis.

c. Demonstrate at least two different types of example to model and analyze bars or plates made from composite material.

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

CO1: Analyze 1-D, 2-D and 3-D problems using Finite Element Procedure and Analytical procedure.

CO2: Demonstrate the ability to obtain deflection of beams.
CO3: Solve truss for nodal displacements, stresses and reactions.
CO4: Apply FEM method to solve 1D Steady State Heat Transfer Problems.
CO5: Carry out dynamic analysis for finding natural frequencies.

Text Books:

1. A first course in the Finite Element Method Logan, D. L Cengage Learning 6th Edition
2. Finite Elements in Engineering Chandrupatla T. R PHI 2nd Edition 2013

Scheme of Examination:

ONE question from part –A : 40 Marks
ONE question from part -B : 40 Marks
Viva –Voice : 20 Marks
Total : 100 Marks (To be reduced to 60 Marks)

|| Jai Sri Gurudev||

ADICHUNCHANAGIRI UNIVERSITY

BGS Institute of Technology

B. E. Mechanical Engineering

Scheme for Seventh Semester Mechanical Engineering

Sl. No	Course Code	Title of the Course	Teaching Department	Teaching Hours/week				Examination				Credits
				L	T	P	TL	Exam Duration in Hours	CIE Marks	SEE Marks	Total Marks	
1	18ME71	Energy Resources	ME	3	0	0	3	3	40	60	100	3
2	18ME72	Control Engineering	ME	4	0	0	4	3	40	60	100	4
Professional Elective– 5												
3	18ME731	Fluid Power Systems	ME	3	0	0	3	3	40	60	100	3
	18ME732	Production operation & Management	ME	3	0	0	3	3	40	60	100	3
	18ME733	Non Destructive Testing	ME	3	0	0	3	3	40	60	100	3
Professional Elective– 6												
4	18ME741	Tribology	ME	3	0	0	3	3	40	60	100	3
	18ME742	IC Engines and Alternate Fuels	ME	3	0	0	3	3	40	60	100	3
	18ME743	Experimental Stress Analysis	ME	3	0	0	3	3	40	60	100	3
Open Elective-1(for other branch Students)												
5	18MEOE75	Automobile Engineering	ME	2	0	0	2	3	40	60	100	2
6	18MEL76	CIM Lab	ME	1	0	2	3	3	40	60	100	2
7	18MEL77	Design Lab	ME	1	0	2	3	3	40	60	100	2
8	18MEPW78	Project Phase-I	ME	--	--	6	6	3	---	100	100	2
TOTAL CREDITS& CONTACT HOURS							**28**		**280**	**520**	**800**	**21**
TOTAL CREDITS OF I SEMESTER TO VI SEMESTER				(I Sem + II Sem+IIISem+IVSem+VSem+VI Sem) 24+24+25+25+26+25= 149								**170**

Course Code	18ME71	Course Title	Energy Resources	Semester	VII
Credits	3	L – T – P –TL*	2 – 1 – 0 – 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to: • Understand global energy reserves of various energy sources. • Discuss various techniques to harness renewable energy sources. • Evaluate the problems encountered in harnessing renewable energy sources. • Describe the storage techniques of future energy sources.	**Teaching Hrs**
Module-1 **Introduction to Energy Sources**: World Energy Features, Indian Energy Scene, Conventional and non-conventional energy sources, Prospects of renewable energy sources. **Solar Energy Source**: Introduction, Solar constant, radiation on Earth's surface, Radiation geometry, Radiation measurements, Radiation data, Average solar radiation, radiation on tilted surfaces, Problems.	**10**
Module-2 **Solar Energy collectors**: Principle of conversion of energy, Flat plate collector, Transmissivity of cover system, Collector energy balance equation, Thermal Analysis of FPC, Useful heat gain, Focusing collectors, advantages and disadvantages, Factors affecting collector performance, Problems. **Application of Solar Energy**: Solar Water Heating, Heating and Cooling of Buildings, Thermo electric conversion, Power generation, PV cells, Solar distillation, Pumping, Cooking.	**8**
Module-3 **Wind Energy**: Principle of energy conversion, Power generation, Forces on blades, energy estimation, Wind data, Components of WECS, Classification of WECS, Advantages and Disadvantages, Types of Wind machines, Performance of Wind machines, Applications of wind energy. Problems. **Energy from Biomass**: Conversion technology, Factors affecting gas generation, classification of biogas plants, Advantages and disadvantages of different types of plants, Problems.	**8**
Module-4 **Fuel Cells**: Design and Principle of operation, Classification, Types, Advantages and disadvantages, Conversion efficiency, Types of electrodes, Work output and EMF of Fuel Cells, Applications of Fuel Cells. **Thermo Nuclear Fusion Energy**: Fusion Reactions, Requirements, Plasma, Magnetic and Inertial Confinement fusion, Muon Catalyzed Fusion, Characteristics of D-T Reaction, Advantages of Nuclear Fission, Fusion Hybrid, Cold Fusion.	**8**

Module-5	
Hydrogen Energy: Properties of Hydrogen with respected to its utilization as a renewable form of energy, sources of hydrogen, production of hydrogen, electrolysis of water, thermal decomposition of water, thermo chemical production bio-chemical production. **Storage & Transportation Methods:** Gaseous, cryogenic and metalhydrides, application of hydrogen, domestic and industrial safe burning of hydrogen.Other Alternate Energy sources, OTEC, Tidal, Waves (Generation and Application).	**8**

Course outcomes: By the end of the course the students can able to:

CO1: Identify energy sources and their utilization.

CO2: Investigate the performance of harnessing techniques used for different energy sources.

CO3: Explain the methods of solar energy measurements and its applications.

CO4: Evaluate the different performance parameters of salient non-conventional system and recommend its utility for modern usage.

Question paper pattern:

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

Textbooks:

1. G.D Rai K, **" Non-Conventional Energy Sources",** Khanna Publishers, 2003.
2. S.P Sukhatme, **"Solar energy",** Tata McGraw Hill, 2nd Edition, 1996.

Reference books:

1. N.K.Bansal, Manfred Kleeman&MechaelMeliss, "**Renewable Energy Sources and Conversion Technology",** Tata McGraw Hill, 2001.
2. B H Khan, **"Non-conventional Resources"**, TMH – 2007.
3. Domakundawar, "**Power Plant Engineering"** Dhanpath Rai Sons.

Course Code	18ME72	Course Title	Control Engineering	Semester	VII
Credits	4	L – T – P – TL*	4– 0 – 0 – 4	Teaching Hrs	56
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to: • Modeling of mechanical, hydraulic, pneumatic and electrical systems. • Representation of system elements by blocks and its reduction • Transient and steady state response analysis of system. • Analysis of system using root locus plots. • Different system compensators and variable characteristics of linear systems.	**Teaching, Hrs**
Module-1 **Introduction:** Concept of automatic controls, Terminology, Open loop control systems(OLCS) and closed loop control systems(CLCS), Comparison of OLCS and CLCS, Concepts of feedback, Effect of Feedback on the control system, Requirements of an ideal control system, **Controllers**: Types of controllers-Two position, Proportional, Integral, Derivative, Proportional & Integral, Effect of Proportional & Integral, Proportional & Derivative, Proportional Integral & Derivative controllers, Derivative control action.	**12**
Module-2 **Block diagram Algebra (BD)**: General representation of a feedback control system, transfer functions, rules of block diagram algebra, reduction of block diagram to obtain closed loop transfer function. Numerical **Signal flow graphs (SFG)**: Basic Elements of a SFG, Terms used in SFG, Properties of SFG and Procedure to Draw SFG. Problems, Mason's gain formula to determine over all Transfer function. Numerical	**12**
Module-3 **Steady state operation:** Standard test inputs unit step, ramp, parabolic, impulse inputs, Order and type of the control system, Effect of standard test inputs on steady state errors, Steady state errors of Type-0, Type-1, and Type-2 unity feedback system. Numerical **Transient Response:** Transient response First order system, Transient response Second order system, Time response specification, System stability, terms used, condition for stability analysis, Routh's Hurwitz stability criterion for a control system. Numerical	**10**
Module-4 **Compensators:** Lag Compensator and its characteristics, Lead Compensator and its characteristics, Lead and Lag Compensator and its characteristics.	**12**

Root Locus Plots: Root locus method: Significance of Root locus, angle and magnitude conditions, breakaway points, angles of departure and arrival, construction of Root locus using general rules and steps. Numerical	
Module-5 **Frequency Response Analysis**: Introduction, Bode plot, angle and magnitude conditions, Procedure to sketch Bode plot, Basic terms used Numerical. **System Compensation and State Variable Characteristics of Linear Systems:** Series and feedback compensation, Introduction to state concepts, state equation of linear continuous data system. Matrix representation of state equations, controllability and observability, Kalman's and Gilberts test. Numerical.	**10**

Course outcomes: By the end of the course the student shall be able to:

CO1: Recognize control system and its types, control actions
CO2: Calculate the gain of the system using block diagram and signal flow graph
CO3: Illustrate the response of 1st and 2nd order systems
CO4: Determine the stability of transfer functions in complex domain and frequency domain
CO5: Employ state equations to study the controllability and observability

Question paper pattern:

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

Text Books:

1. Modern control theory, Katsuhiko Ogata, Pearson Education International , Fifthedition.
2. Control systems Principles and Design, M.Gopal, 3rd Edition, TMH,2000.

Reference Books:

3. Control system engineering, Norman S Nise, John Wiley &Sons, Inc., Sixthedition
4. Modern control systems, Richard C. Dorf, Robert H Bishop, Pearson Education International, Twelfthedition.
5. Automatic control systems, Farid Golnaraghi, Benjamin C Kuo, John Wiley & Sons, Inc., Ninethedition
6. J.Nagrath and M.Gopal, Control System Engineering, New Age International Publishers, 5th Edition,2007
7. Feedback control systems, Schaum's series,2001.
8. System dynamics and control, Eronini-Umez, Thomas Asia Pte ltd., Singapore2002.

Course Code	18ME731	Course Title	Fluid Power Systems	Semester	VII
Credits	3	L – T – P –TL*	3 –0 – 0 – 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to: • Provide an insight into the capabilities of hydraulic and pneumatic power. • Familiarize concepts and relationships surrounding force, pressure, energy and power in fluid power systems. • Examine concepts cantering on sources of hydraulic power, rotary and linear actuators, distribution systems, and control components in fluid power systems. • Exposure to build and interpret hydraulic and pneumatic circuits.	**Teaching, Hrs**
Module-1 **Introduction to Hydraulic Power:** Pascal's law and problems on Pascal's Law. Structure of fluid power system. Reservoirs: constructional features and functions. Sealing devices: Types and materials used. Filters: Types, materials used and locations. Hydraulic fluids: Properties and types. **HydraulicPumps:** The Source of hydraulic power (Pumps): Classification of pumps and constructional features (gear, lobe, vane and piston pumps). Pump selection parameters. Problems on performance of pumps.	**8**
Module-2 **Hydraulic Actuators:** Rotary actuators (Hydraulic motors): Types and constructional features (gear motor, vane motor and piston motors). Problems on performance of hydraulic motors. **Linear Actuators:** Hydraulic cylinders: Constructional features and types. End position cushioning and mounting arrangements of cylinders. Mechanics of cylinder loading. Problems on performance of cylinder.	**8**
Module-3 **Components in Hydraulic Systems:** Directional Control Valves – Classification, actuation methods with symbolic representations. **Pressure control valves** – Types with symbolic representations. Flow control valves, Types with symbolic representations. Accumulators, Types and applications.	**8**
Module-4 **Hydraulic Circuits and Applications:** Hydraulic circuit design considerations, controlling of single and double acting cylinders. Regenerative cylinder circuit, counterbalance valve application, cylinder sequencing circuits, automatic cylinder reciprocating system. **Introduction to Pneumatic Control:** Properties of air, gas laws, structure of pneumatic control system, characteristics of compressed air. Compressors: Classifications and working principles (Piston, vane and screw compressors). Preparation of compressed air, filters, pressure regulators, lubricators and silencers.	**10**

Module-5	
Components in Pneumatic Systems: Direction control valves, check valves, shuttle valves, two pressure valve and flow control valves – applications and functions. Quick exhaust valve and Time delay valve (constructional features). Pneumatic Actuators. **Pneumatic Circuits:** Pneumatic circuit design considerations, controlling of single and double acting cylinders.	**8**

Course outcomes: By the end of the course the students should be able to:

CO1: Explain the construction, operation and performance characteristics of different types of pumps.
CO2: Identify and explain the operations and applications of hydraulic actuators, valves and other hydraulic system components.
CO3: Build basic hydraulic circuits and applications to execute desired functions.
CO4: Explain the basic principles and applications of pneumatic system.
CO5: Identify and explain operations and applications of pneumatic system components and basic pneumatic circuits.

Question paper pattern:

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

Text Books:

1. Anthony Esposito, Fluid Power with Applications, Seventh Edition, Pearson Education, Inc. 2014. ISBN: 978-93-325-1854-4.
2.S.R. Majumdar, Oil Hydraulic Systems - Principles and Maintenance**,** Tata McGraw Hill, 2010, ISBN: 0-07-463748-7.
3. S. R. Majumdar, Pneumatic systems – Principles and Maintenance, Tata McGraw Hill, 2011, ISBN-13:978-0-07-460231-7.

Reference Books:

1.R. Srinivasan, Hydraulic and pneumatic controls, Second edition, McGraw Hill Education pvt. Ltd. 2009, ISBN: 978-81-8209-138-2.
2.John Pippenger, Tyler Hicks, "Industrial Hydraulics", McGraw Hill International Edition, 1980.
3. Andrew Par, Hydraulics and pneumatics, Jaico Publishing House, 2005.
4. FESTO, Fundamentals of Pneumatics, Vol I, II and III.

Course Code	18ME732	Course Title	Production & Operation Management	Semester	VII
Credits	3	L – T – P –TL*	3 – 0 – 0 – 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to: • Understand the approaches for designing and improving process. • Use relevant tools and techniques to solve production and operations management problems. • Have an insight about the delivery of service in an organization.	**Teaching Hrs**
Module-1 **Operations Planning Concepts**: Introduction, Operations Functions in Organizations, Historical development, Framework for managing operations, The trend: Information and Non-manufacturing systems, **Operations management**: Factors affecting productivity, International dimensions of productivity, The environment of operations, Production systems decisions- a look ahead. Introduction to ERP.	**10**
Module-2 **Operations Decision Making** : Introduction, Management as a science, Characteristics of decisions, Framework for decision making, Decision methodology, Decision Tree Problems, Economic models, Break Even Analysis in operations, P/V ratio, Statistical models. System Design and Capacity, Introduction, Manufacturing and service systems, Design and systems capacity, Capacity planning. **Inventory Management :** Types of Inventories, independent and dependent demand, reasons for holding inventory, objectives of inventory control, requirements for effective inventory management – information, cost, priority system. Inventory control and economic-order-quantity models.	**8**
Module-3 **Forecasting Demand**: Forecasting objectives and uses, Forecasting variables, Opinion and Judgmental methods, Time series methods, Moving Average methods, Exponential smoothing, Trend adjusted Exponential Smoothing, Regression and correlation methods 1 **Role of Operations Management**: Role of production and Operations Management in Flexible manufacturing system (FMS), Robotics, Computer integrated manufacturing (CIM), Service orientation and customer focus.	**8**
Module-4 **Aggregate Planning and Master Scheduling**: Introduction- planning and scheduling, Objectives of aggregate planning, Three Pure Strategies, Aggregate planning methods, Master scheduling objectives, Master scheduling methods. Material Capacity Requirements Planning: Overview: MRP and CRP, MRP: Underlying concepts, System parameters, MRP logic, System refinements, Capacity management, CRP activities	**8**
Module-5 **Scheduling and Controlling Production Activities**: Introduction, PAC, Objectives and Data requirements, Loading –Finite and	**8**

Infinite Scheduling methodology, priority sequencing, capacity control, Single Machine Scheduling: Concept, measures of performance, SPT rule, Weighted SPT rule ,EDD rule **Purchasing and Supply Chain Management(SCM):**Introduction, Importance of purchasing and SCM, The procurement process, Concept of tenders, Approaches to SCM, Vendor development, Measures of purchasing and SCM, Make or buy decision, Types of buying, E-procurement.	

Course outcomes: After a successful completion of the course, the student will be able to:

CO1: Describe the basic concept of OM, manufacturing trends in INDIA.

CO2: Design of product layout, process layout and analyse process and capacity.

CO3: Applying appropriate inventory planning technique.

CO4: Forecast the demand and prepare MPS.

CO5: Constructing MRP, MRPII and schedule the jobs and machines.

Question paper pattern:

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

Text Books:

1. Monks, J.G., Operations Management, McGraw-Hill International Editions, 1987
2. Roberta S Russel, Bernard W Taylor III, Operations Management, Pearson Education, Fifth Edition 2005.
3. Chase, Jacobs, Aquilano, Operations Management for Competitive Advantage, Tata McGraw Hill , 11th Edition 2006.
4. Production and Operations Management , Ajay Garg, Tata McGraw-Hill Education, 2012

Reference Books:

1. Buffa, Modern Production/Operations Management, Wiely Eastern L
2. Chary, S.N., Production and Operations Management, TataMcGraw Hill
3. Operations management by James Dilworth
4. Lee J Karjewski and Larry P Ritzman, Operations Management – strategy and Analysis, 6thEdn, Pearson Education Asia

Course Code	18ME733	Course Title	Non-Destructive Testing	Semester	VII
Credits	3	L – T – P - TL*	3– 0 – 0 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T-Tutorial; P – Practical; TL – Total; CIE – Continuous Internal Evaluation; SEE – Semester End Examination**	
Course Learning Objectives: This course will enable students to: • To introduce the basic principles, techniques, equipment, applications and limitations of NDT methods. • To identify advantages and limitations of nondestructive testing methods • To enable selection of appropriate NDT methods.	**Teaching, Hrs**
Module-1 **Introduction to ND Testing:** Selection of ND methods, visual inspection, leak testing, Liquid penetration inspection, its advantages and limitation. **Magnetic Particle Inspection:** Methods of generating magnetic field, types of magnetic particles and suspension liquids steps in inspection – application and limitations.	**8**
Module-2 **Eddy Current Inspection:** principles, operation variables, procedure, inspection coils, and detectable discounts by the method. **Ultrasonic Inspection:** Basic equipment characteristics of ultrasonic waves, variables inspection, inspection methods pulse echo A,B,C scans transmission, resonance techniques, transducer elements couplets, search units, contact types and immersion types inspection standards-standard reference blocks	**10**
Module-3 **Radiography Inspection**: principles, radiation source X-rays and gamma rays, X-ray-tube, radio graphic films, neutron radiography, Thermal inspection principles, equipment inspection methods applications. **Penetration Testing Material:** Penetrant, cleaners and emulsifier, developers, special requirements, penetrant testing method, water washable method, post-emulsified method, solvent removable method.	**8**
Module-4 **Optical Holography:** Basics of Holography, recording and reconstruction - Acoustical Holography: systems and techniques applications. Indian standards for NDT. **Microwave Inspection:** Microwave holography, applications and limitations.	**8**
Module-5 **Thermo graphic methods**: Acoustic emission, Total acoustic emission, felicity ratio, Generation of Acoustic Emission. **Leak Testing:** Measurement of leakages, leak testing methods, leak detection, bubble testing, helium leak detector.	**8**
Course Outcomes: By the end of the course, the students should be able to: • Explain Principles of selection of NDE.	

• Describe various inspection methods like Magnetic particle, Radiographic Inspection their Principle, general procedure, advantages and limitations. • Verify proper assembly and Inspect for in-service damage.	
Question Paper Pattern: • The question paper will have ten full questions carrying equal marks. • Each full question will be for 20 marks. • There will be two full questions (with a maximum of four sub-questions) from each module. • Each full question will have sub-question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module.	
Text Books: **1.** Practical Non-Destructive Testing Baldev Raj, T.Jayakumar, M.ThavasimuthuNarosa Publishing House 2009 **2.** Non-Destructive Testing Techniques Ravi Prakash New Age International Publishers 1st revised edition2010	
Reference Books **1.** Non Destructive Testing - McGonnagle JJ – Garden and reach New York. **2.** Non Destructive Evolution and Quality Control - volume 17 of metals hand book 9 edition Asia internal 1989.	

Course Code	18ME741	Course Title	Tribology	Semester	VII
Credits	3	L – T – P - TL*	3– 0 – 0 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T-Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

	Teaching, Hrs
Course Learning Objectives: This course will enable students to: • Understand the concepts of friction, lubrication, and wear. • Familiarize with mathematical tools used to analyze tribological processes. • Identify, formulate, and solve engineering problems. • Understand the principles of lubrication.	
Module-1 **Introduction to Tribology:** Introduction, Friction, Wear, Wear Characterization, Regimes of lubrication Classification of contacts, lubrication theories, Concept of lightly loaded bearings, Petroff's equation, **Viscosity:**Effect of pressure and temperature on viscosity. Newton's Law of viscous forces, Flow through stationary parallel plates. Hagen's Poiseuille's theory, viscometers. Numerical.	**8**
Module-2 **Hydrodynamic Lubrication:** Pressure development mechanism. Converging and diverging films and pressure induced flow. Reynold's equation in two dimensions with assumptions. Introduction to idealized slide bearing with fixed shoe and Pivoted shoes. Expression for load carrying capacity. Location of center of pressure, effect of end leakage on performance, Numerical. **Journal Bearings:** Introduction to idealized full journal bearings. Load carrying capacity of idealized full journal bearings, Sommerfeld number and its significance, short and partial bearings, Comparison between lightly loaded and heavily loaded bearings, effects of end leakage on performance, Numerical.	**10**
Module-3 **Introduction to idealized journal bearing**, load carrying capacity, condition for equilibrium, Sommerfeld's numbers and significance of it; Partial bearings, end leakages in journal bearing, numerical problems. **Pressure distribution**, Load carrying capacity, coefficient of friction, frictional resistance in a pivoted shoe bearing, Numerical examples.	**8**
Module-4 **Bearing Materials**: Commonly used bearings materials, properties of typical bearing materials. Advantages and disadvantages of bearing materials. **Behavior of Tribological Components:** Selection, friction, Wear of ceramic materials, wear measurements, effects of speed, temperature and pressure. Tribological measures, Material selection, improved design, surface engineering.	**8**
Module-5 **Antifriction bearings:** Advantages, selection, nominal life, static and dynamic load earing capacity, probability of survival, equivalent load, cubic mean load, bearing Mountings.	**8**

Porous Bearings: Introduction to porous and gas lubricated bearings. Governing differential equation for gas lubricated bearings,Equations for porous bearings and working principal, Fretting phenomenon and its stages.	
Course Outcomes: By the end of the course, the students should be able to: CO1: Design or choose efficient tribological systems. CO2: Specify bearings for different application CO3: Select compatible materials for minimizing friction and wear in machinery. CO4: Explain the concepts advanced bearings like, porous bearings.	
Question Paper Pattern: • The question paper will have ten full questions carrying equal marks. • Each full question will be for 20 marks. • There will be two full questions (with a maximum of four sub-questions) from each module. • Each full question will have sub-question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module.	
Text Books: 1. Mujamdar.B.C "Introduction to Tribology of Bearing", Wheeler Publishing, New Delhi 2001 2. Radzimovsky, "Lubrication of Bearings - Theoretical principles and design" Oxford press Company, 2000. **Reference Books:** 1. Dudley D.Fulier " Theory and practice of Lubrication for Engineers", New York Company.1998 2. Moore "Principles and applications of Tribology", Pergamon press, 1975. 3. Oscar Pinkus, BenoSternlicht, “Theory of hydrodynamic lubrication”, McGraw-Hill, 1961. 4. G W Stachowiak, A W Batchelor ,“Engineering Tribology”, Elsevier publication 1993. 5. Hydrostatic and hybrid bearings, Butterworth 1983.	

Course Code	18ME742	Course Title	I C Engines and Alternate Fuels	Semester	VII
Credits	3	L – T – P - TL*	3– 0 – 0 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60
*NOTE: L – Lecture; T-Tutorial; P – Practical; TL – Total; CIE – Continuous Internal Evaluation; SEE – Semester End Examination					

Course Learning Objectives: This course will enable students to: • Understand the fundamental concepts of IC engines. • Equip with the fundamental knowledge on the thermodynamics and performance of internal combustion engines with base fuels and alternate fuels. • Understand about emissions and emission norms imposed to IC engines.	**Teaching, Hrs**
Module-1 **Introduction to IC Engines:** Heat Engines, Development, and classification of IC engines, Engine Structure and its components, Engine Nomenclature, Working, Application, Thermodynamic analysis of IC engines. Actual working of 4-stroke Petrol and Diesel engines and valve timing diagrams, **Two stroke engines:** Actual working of 2-stroke petrol and Diesel engines and the corresponding port timing diagram, comparison of SI and CI engines, Engine power and efficiencies. Numerical.	**8**
Module-2 **Combustion in SI Engines:** Mixture requirements in SI engine, Stages of Combustion, normal and abnormal combustion, knocking and its effect on performance, Flame propagation and factors affecting it, knock measurement, Octane number, Anti knock agents, Pre-ignition and post ignition. **Combustion in CI Engines:** Stages of combustion, Delay period and factors affecting delay period, Detonation, factors affecting, and controlling of detonation in CI engines, Rating of CI engine fuels, Comparison of knocking in SI and CI engines.	**10**
Module-3 **Fuels:** Introduction,Hydrocarbon fuels, chemical structures, need for alternate fuel, availability and properties of alternate fuels. Alcohols and ethers: Effect of blends of alcohols and ethers on the performance of SI and CI engines. **CNG, LPG and Biogas:** Modifications required in engines, performance and emission characteristics of CNG and LPG in SI and CI engines.	**8**
Module-4 **Vegetable Oils:** Various vegetable oils for engines, esterification, performance and emission characteristics of vegetable oils, biodiesel and its characteristics. **Modern developments:** Turbo charging and supercharging of IC engines, Stratified charge engines, Multifuel engines.	**8**
Module-5 **Emission regulation and control systems:** Emissions of SI and CI engines, Mechanism of pollutant formation. Total emission control package; thermal reactor package; catalytic converter package.	**8**

Control of NOx: Exhaust gas Recirculation; Water injection.	
Course Outcomes: By the end of the course, the students should be able to: CO1: Summarizes the constructional and operational features of IC engines. CO2: Identify the requirements of combustion process for SI and CI engines. CO3: Enumerate the significance of alternate fuels in the current scenario. CO4: Discuss modern developments of engines. CO5: Review the methods to reduce knocking tendency and means to control pollution.	
Question Paper Pattern: • The question paper will have ten full questions carrying equal marks. • Each full question will be for 20 marks. • There will be two full questions (with a maximum of four sub-questions) from each module. • Each full question will have sub-question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module.	
Text Books: 1. V. Ganesan, Internal Combustion Engines, TMH, 4th Edition, 2012, ISBN: 9781259006197. 2. M. L. Mathur and R.P. Sharma, Internal Combustion Engine, Dhanpat Rai Publications, 2001. **Reference Books:** 1. R. K. Rajputh, A Text Book of Internal Combustion Engines, Laxmi Publishers (P) Ltd, 3rd Edition, 2016, ISBN: 9788131800669. 2. John B. Heywood, Internal Combustion Engine Fundamentals, Mc Graw Hill Education, Indian Edition.	

Course Code	18ME743	Course Title	Experimental Stress Analysis	Semester	VII
Credits	3	L – T – P - TL*	3– 0 – 0 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T-Tutorial; P – Practical; TL – Total; CIE – Continuous Internal Evaluation; SEE – Semester End Examination**	
Course Learning Objectives: This course will enable students to: This course focuses on stress-strain relations, yield criteria and associated flow rules for elastic-plastic analysis of components and structures.	**Teaching, Hrs**
Module-1 **Introduction** Definition of terms, Calibration, Standards, Dimension and units generalized measurement system. Basic concepts in dynamic measurements, system response, distortion, impedance matching, Analysis of experimental data, cause and types of experimental errors. General consideration in data analysis. **Analysis of Experimental Data:** Experimental errors, error analysis, statistical analysis of experimental data, probability distribution, Gaussian distribution, Chi-Square test method of least square, correlation coefficient.	**8**
Module-2 **Strain Analysis Methods:** Two element, three element rectangular and delta rosettes, Correction for transverse strain effects, Stress gage, Plane shear gage, Stress intensity factor gage. **Data Acquisition and Processing:** General data acquisition system, signal conditioning, data transmission, analog to digital and digital to analog conversion. Basic components (storage and display) of data acquisition system.	**10**
Module-3 **Photoelasticity**: Nature of light, Wave theory of light - optical interference, Stress optic law –effect of stressed model in plane and circuclar polariscopes, Isoclinics& Isochromatics, Fringe order determination Fringe multiplication techniques, Calibration photoelastic model materials. **Two Dimensional Photoelasticity**: Separation methods: Shear difference method, Analytical separation methods, Model to prototype scaling, Properties of 2D photoelastic model materials, Materials for 2D photoelasticity.	**8**
Module-4 **Three Dimensional Photo elasticity:** Stress freezing method, Scattered lightphotoelasticity, Scattered light as an interior analyzer and polarizer, Scattered lightpolariscope and stress data Analyses. **Photoelastic (Birefringent) Coatings** :Birefringence coating stresses, Effects of coating thickness: Reinforcing effects, Poission's, Stress separation techniques: Oblique incidence, Strip coatings.	**8**
Brittle Coatings: Coatings stresses, Crack patterns, Refrigeration techniques, Load relaxation techniques, Crack detection methods, Types of brittle coatings, Calibration of coating. Advantages and brittle coating applications. **Moire Methods**: Moire fringes produced by mechanical interference .Geometrical approach, Displacement field approach to Moire fringe analysis, 0ut of plane displacement measurements, Out of plane slope measurements .Applications and advantages	**8**

Course Outcomes: By the end of the course, the students should be able to: CO1: Mount strain gauges, take measurements and analyze obtained data. CO2: Design strain gauges for measuring specific loads. CO3: Describe the different methods of photoelasticity and photoelastic coatings. CO4: Explain the principles and techniques of brittle coatings and Moire methods.	
Question Paper Pattern: • The question paper will have ten full questions carrying equal marks. • Each full question will be for 20 marks. • There will be two full questions (with a maximum of four sub-questions) from each module. • Each full question will have sub-question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module.	
Text Books: 1. "Experimental Stress Analysis", Dally and Riley, McGraw Hill. 2. "Experimental Stress Analysis". Sadhu Singh, Khanna publisher. 3. Experimental stress Analysis, Srinath L.S tata Mc Graw Hill. **Reference Books:** 1. "Photoelasticity Vol I and Vol II, M.M.Frocht, John Wiley & sons. 2. "Strain Gauge Primer", Perry and Lissner, 3. "Photo Elastic Stress Analysis", Kuske, Albrecht & Robertson John Wiley & Sons. 4. "Motion Measurement and Stress Analysis", Dave and Adams, 5. Holman, Experimental Methods for Engineers, Tata McGraw-Hill Companies, 7th Edition, New York, 2007.	

Course Code	18MEL76	Course Title	CIM Lab	Semester	VI
Credits	2	L – T – P –TL*	1 – 0 – 2 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to;

- 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
- To educate the students on the usage of CAM packages and cut part on virtual CNC machine simulator.
- To make the students understand the importance of automation in industries through exposure to FMS, Robotics, and Hydraulics and Pneumatics.

Teaching Hrs

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: Cadem CAM Lab-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. Enter program, take tool offsets, cut part in single block and auto mode, measure the virtual part on screen in the virtual CNC machine simulator, for standard CNC control systems FANUC, FAGOR, HAAS and SINUMERIK.

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.

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

CO1: Generate CNC Lathe part program for Turning, Facing, Chamfering, Grooving, Step turning, Taper turning, Circular interpolation.

CO2: Generate CNC Mill Part programming for Point to point motions, Line motions, Circular interpolation, Contour motion, Pocket milling- circular, rectangular, Mirror commands etc.
CO3: Use Canned Cycles for Drilling, Peck drilling, Boring, Tapping, Turning, Facing, Taper turning Thread cutting etc.
CO4: Simulate Tool Path for different Machining operations of small components using CNC Lathe & CNC Milling Machine.
CO5: Use high end CAM packages for machining complex parts; use state of art cutting tools and related cutting parameters; optimize cycle time; set up and cut part on.

Textbooks:

1. Automation, Production Systems and Computer-Integrated Manufacturing, by Mikell P Groover, 4th Edition, 015, 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. Computer Integrated Manufacturing, J. A. Rehg& Henry. W. Kraebber.
5. CAD/CAM by Zeid, Tata McGraw Hill.

Scheme of Examination:
TWO questions from part -A: 80 Marks
Viva -Voice: 20 Marks
Total: 100 Marks (To be reduced to 60 Marks)

Course Code	18MEL78	Course Title	Design Lab	Semester	VI
Credits	2	L – T – P –TL*	1 – 0 – 2 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60
*NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total; CIE – Continuous Internal Evaluation; SEE – Semester End Examination					

Course Learning Objectives: This course will enable students to; • Understand the natural frequency, logarithmic decrement, damping ratio. • Understand the balancing of rotating masses. • Understand the critical speed of rotating shafts. • Understand photoelastic stress analysis. • Understand working principles of governor.	**Teaching Hrs**
PART – A 1. Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (longitudinal and torsional) 2. Balancing of rotating masses. 3. Determination of critical speed of a rotating shaft. 4. Determination of Fringe constant of Photo elastic material using. a) Circular disc subjected to diametral compression. b) Pure bending specimen (four point bending) 5. Determination of stress concentration using Photoelasticity for simple components like plate with a hole under tension or bending, circular disk with circular hole under compression, 2D Crane hook. **PART – B** 6. Determination of equilibrium speed, sensitiveness, power and effort of Porter/Prowel /Hartnel Governor. (only one or more) 7. Determination of Pressure distribution in Journal bearing. 8. Determination of Principal Stresses and strains in a member subjected to combined loading using Strain rosettes. 9. Determination of stresses in Curved beam using strain gauge. 10. Experiments on Gyroscope (Demonstration only)	
Course Outcomes: At the end of the course, the student will be able to: CO1: Evaluate damping coefficient in a single degree freedom system.	

CO2: Demonstrate Balancing of Rotating masses Experimentally.
CO3: Evaluate longitudinal, Torsional and forced vibration in systems.
CO4: Evaluate performance of Governors and Gyroscopic effect experimentally
CO5: Draw the pressure distribution around Journal bearing through Experimentation
CO6: Evaluate the stresses through strain rosettes, and photo elasticity bench.

Text Books:

1. Joseph Edward Shigley, Mechanical Engineering Design, Mc. Graw Hill, 8th Edition, 2008. ISBN:9780073529288.
2. V.B.Bhandari, Design of Machine Elements, TMH, 3rd Edition2007.ISBN: 9780070681748.

Scheme of Examination:

ONE question from part –A : 40 Marks
ONE question from part -B : 40 Marks
Viva –Voice : 20 Marks
Total : 100 Marks (To be reduced to 60 Marks)

Course Code	18MEPW78	Course Title	Project Phase-I	Semester	VIII
Credits	6	L – T – P- TL*	0– 0 – 6- 6	Teaching Hrs	---
Total Marks	100	CIE*	--	SEE*	100
*NOTE: L – Lecture; T-Tutorial; P – Practical; TL – Total; CIE – Continuous Internal Evaluation; SEE – Semester End Examination					

|| Jai Sri Gurudev||

ADICHUNCHANAGIRI UNIVERSITY

BGS Institute of Technology

B. E. Mechanical Engineering

Scheme for Eight Semester Mechanical Engineering

Sl. No	Course Code	Title of the Course	Teaching Department	Teaching Hours/week				Examination				Credits
				L	T	P	TL	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
1	18ME81	Operation Research	ME	4	1	0	5	3	40	60	100	4
2	18ME82	Additive Manufacturing	ME	3	0	0	3	3	40	60	100	3
	Professional Elective-7											
3	18ME831	Research Methodology &Intellectual Property Rights	ME	3	0	0	3	3	40	60	100	3
	18ME832	Mechatronics	ME	3	0	0	3	3	40	60	100	3
4	18METS84	Technical Seminar	ME	0	0	6	0	6	--	100	100	2
5	18MEPW85	Project work phase II	ME	0	0	18	0	18	40	60	100	6
6	18MEIN86	Internship	ME	0	0	6	0	6	--	100	100	2
TOTAL CREDITS & CONTACT HOURS							**05**	**36**	**160**	**440**	**600**	**20**
TOTAL CREDITS OF I SEMESTER TO VII SEMESTER				(I Sem + II Sem+III Sem+ IV Sem+ V Sem+ VI Sem + VII Sem) 24+24+25+25+26+25+21= 170								**190**

Course Code	18ME81	Course Title	Operation Research	Semester	VIII
Credits	4	L – T – P - TL*	4– 1 – 0 - 5	Teaching Hrs	56
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T-Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

	Teaching, Hrs
Course Learning Objectives: This course will enable students to: • Understand the scientific methods of providing various departments of an organization with a quantitative basis of decision making. • Apply the fundamental techniques of Operations Research to formulate and solve problems involving Linear Programming and heuristic approaches.	
Module-1 **Introduction:** Evolution of OR, Definition of OR, Scope of OR, Application areas of OR, Phases in OR study. Characteristics and limitations of OR, models used in OR. **Linear Programming Problems (LPP):** Introduction, Mathematical formulation of LP Problems. Solutions to LPP by graphical method.	**10**
Module-2 **Linear Programming Problems (LPP):** The Simplex method- canonical and standard form of an LP problem, slack, surplus and artificial variables, Big-M method and Two-Phase method, Degeneracy in Simplex method and its resolution. **Duality**: Primal and dual concept, Dual Simplex method.	**12**
Module-3 **Transportation Problem:** Formulation of transportation problem, types, Initial basic feasible solution using North West Corner Method (NWCM), Least Cost Method (LCM) and Vogel's Approximation Method (VAM), Optimal solution by MODI method. Unbalanced transportation problem, Degeneracy in transportation problems, Applications of Transportation problems, concept for maximization cases. **Assignment Problem:** Formulation, types, Hungarian technique, unbalanced assignment problem, Special cases in assignment problems, applications of assignment for maximization cases. Travelling Salesman Problem (TSP) and its applications.	**12**
Module-4 **Game Theory:** Introduction, Formulation of games, Two Person-Zero sum game, games with and without saddle point, graphical method of solving mixed strategy games. Principle of Dominance for solving mixed strategy games. **Sequencing:** Introduction, basic assumptions, Johnson's algorithm, sequencing *n* - jobs on *2* machines, *n* jobs on *3* machines, *n* jobs on *m* machines without passing sequence. Sequencing *2* jobs on *m* machines using graphical method.	**10**
Module-5 **PERT-CPM Techniques:** Introduction, Network construction, Fulkerson's rule of numbering the events, AON and AOA diagrams; Critical path method to find expected completion time of a project, determination of floats in networks, determining the probability of completing a project, predicting the completion time of project;	**12**

Queuing Theory: Introduction, queuing systems and their characteristics, Kendall & Lee's notation of queuing. Numerical on M/M/1 queuing models.	
Course Outcomes: By the end of the course, the students should be able to: CO1: Realize the importance of operations research & acquire skills to develop linear programming mathematical models to real world problems. CO2: Optimally allocate limited resources such as men, materials, machines, time and money. CO3: Analyze and Execute optimization techniques for game theory and sequencing problems. CO4: Apply optimization techniques like PERT & CPM in Project Management. CO5:Appraise the significance of Queuing theory and solve waiting line problems.	
Question Paper Pattern: • The question paper will have ten full questions carrying equal marks. • Each full question will be for 20 marks. • There will be two full questions (with a maximum of four sub-questions) from each module. • Each full question will have sub-question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module.	
TEXT BOOKS: 1. Prem Kumar Gupta and D.S. Hira, Operations Research, S Chand Pub, New Delhi, 2007, ISBN: 9788121941006 2. Dr. Ranganatha Swamy L. and Dr. B.K. Narendra, Operations Research, Sunstar Publisher, 2019, ISBN: 9789386550774 3. J. K. Sharma, Operations Research, Macmillan Publishers India Ltd, 5th Edition, ISBN: 9789350593363 **REFERENCE BOOKS**: 1. A. M. Natarajan, P. Balasubramani and A Tamilaravari, Operations Research, Pearson 2005, ISBN: 9788131700006. 2. Taha H.A, Operations Research, Pearson Education edition, 8th edition, 2007, ISBN: 9780131889231 3. Ravindran, Phillips and Solberg, Operations Research: Principles and practice: Wiley India ltd, 2nd Edition 2007 ISBN: 9788126512560	

Course Code	18ME82	Course Title	Additive Manufacturing	Semester	VIII
Credits	3	L – T – P - TL*	3– 0 – 0 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60

***NOTE: L – Lecture; T-Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

	Teaching, Hrs
Course Learning Objectives: This course will enable students to: • Understand the additive manufacturing process, polymers and powder metallurgy process • Understand different process of Nano materials in additive manufacturing. • Acquire knowledge on microscopic studies.	
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, postprocessing. **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.	**8**
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, andTriacs. Hydraulic and Pneumatic actuators, Design of Hydraulic and Pneumatic circuits.	**10**
Module-3 **Basic Concepts of polymers:** 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. **Powder Metallurgy:** Introduction and History of Powder Metallurgy (PM), Present and Future Trends of PMDifferent Mechanical and Chemical methods, Atomization of Powder, other emerging processes.	**8**
Module-4 **Introduction:** Importance of Nanotechnology, Emergence of Nanotechnology, Bottom-up 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 Vapor Condensation(CVC).	**8**

Module-5 **Microscopy:**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.	**8**
Course Outcomes: By the end of the course, the students should be able to: CO1: Describe the different process of Additive Manufacturing. CO2: Use Polymer, Powder and Nano materials in Additive Manufacturing. CO3: Analyze the synthesis and processing of Nanomaterials. CO4: Demonstrate the skills in using Microscopes.	
Question Paper Pattern: • The question paper will have ten full questions carrying equal marks. • Each full question will be for 20 marks. • There will be two full questions (with a maximum of four sub-questions) from each module. • Each full question will have sub-question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module.	
Text Books: 1. 1. Chua Chee Kai, Leong Kah Fai, "Rapid Prototyping: Principles & Applications", World Scientific,2003. 2. G Odian Principles of Polymerization, Wiley Interscience 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. MikellPGroover,Automation,ProductionSystemsandComputerIntegratedManufacturing,3rdEdition,PrenticeHallInc.,NewDelhi, 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 Hill1999 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.	

Course Code	18ME831	Course Title	Research Methodology &Intellectual Property Rights	Semester	VIII
Credits	3	L – T – P - TL*	3– 0 – 0 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60
*NOTE: L – Lecture; T-Tutorial; P – Practical; TL – Total; CIE – Continuous Internal Evaluation; SEE – Semester End Examination					
Course Learning Objectives: This course will enable students to: • Give an overview of the research methodology and explain the technique of defining a research problem • Explain the functions of the literature review in research. • Explain carrying out a literature search, its review, developing theoretical and conceptual frameworks • Analyze various research designs and their characteristics. • To explain the details of sampling designs, and also different methods of data collections. • Explain the art of interpretation and the art of writing research reports.					**Teaching, Hrs**
Module-1 **Research Methodology**: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, **Scientific Methods of Research:** Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India.					**8**
Module-2 **Defining the Research Problem:** Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, **Review of Research Methodology:** Broadening knowledge base in research area, enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed.					**10**
Module-3 **Research Design:** Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, **Basic Principles of Experimental Design:** Important Experimental Designs. Design of Sample Surveys: Sample Design, Sampling and Non-Sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs..					**8**
Module-4 **Data Collection:** Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method. Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation. **Report Writing**: Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report,					**8**

Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Making Scientific Presentations in Conferences and Seminars, Professional Ethics in Research.	
Module-5 **Concepts of Intellectual Property Rights:** The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, **Industrial Designs,** Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Enforcement of Intellectual Property Rights.	**8**
Course Outcomes: By the end of the course, the students should be able to: CO1: Discuss research methodology and the technique of defining a research problem CO2: Explain the functions of the literature review in research. CO3: Discuss various research designs and their characteristics. CO4: Explain the art of interpretation and the art of writing research reports. CO5: Filing a Patent.	
Question Paper Pattern: • The question paper will have ten full questions carrying equal marks. • Each full question will be for 20 marks. • There will be two full questions (with a maximum of four sub-questions) from each module. • Each full question will have sub-question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module.	
Text Books: 1. Stuart Melville and Wayne Goddard, ―Research methodology: An introduction for science &Engineering students 2. Wayne Goddard and Stuart Melville, ―Research Methodology: An Introduction **Reference Books:** 1. Ranjit Kumar, 2nd Edition, ―Research Methodology: A Step by Step Guide for beginners 2. Mayall, ―Industrial Design‖, McGraw Hill, 1992. 3. Niebel, ―Product Design‖, McGraw Hill, 1974.	

Course Code	18ME832	Course Title	Mechatronics	Semester	VIII
Credits	3	L – T – P - TL*	3– 0 – 0 - 3	Teaching Hrs	42
Total Marks	100	CIE*	40	SEE*	60
*NOTE: L – Lecture; T-Tutorial; P – Practical; TL – Total; CIE – Continuous Internal Evaluation; SEE – Semester End Examination					

Course Learning Objectives: This course will enable students to: • Understand key elements of Mechatronics system. • Substantiate the need for interdisciplinary study in technologyeducation. • Understand the applications of microprocessors in various systems and to know the functions of eachelement • Understand the concept of PLC system and significance of PLC systems in industrial application • Demonstrate the integration philosophy in view of Mechatronicstechnology	**Teaching, Hrs**
Module-1 **Introduction:** Definition, Multidisciplinary Scenario, Evolution of Mechatronics, Objectives, advantages and disadvantages of Mechatronics. **Transducers and sensors:** Definition and classification of transducers, Difference between transducer and sensor, Definition and classification of sensors, Hall Effect sensors.	**8**
Module-2 **Microprocessor &Microcontrollers:** Introduction, Microprocessor systems, Basic elements of control systems, Microcontrollers, Difference between Microprocessor and Microcontrollers. **Microprocessor Architecture**: Microprocessor architecture and terminology-CPU, memory and address, I/O and Peripheral devices, ALU, Intel's 8085A Microprocessor.	**10**
Module-3 **Programmable logic controller:** Introduction to PLC's, basic structure, Principle of operation, Programming and concept of ladder diagram, selection of a PLC. **Robot**: Industrial Robot, different parts of a Robot-Controller, Drive, Arm, End Effectors, Sensor & Functional requirements of robot.	**8**
Module-4 **Mechanical actuation systems**: Mechanical systems, types of motion, Cams, Gear trains, Ratchet & Pawl, belt and chain drives. **Electrical actuation systems:** Electrical systems, Mechanical switches, Solenoids, Relays.	**8**
Module-5 **Pneumatic actuation systems**: Actuating systems, Pneumatic systems, Classifications of Valves, Pressure relief valves, Pressure regulating/reducing valves, Cylinders and rotary actuators. **Hydraulic actuation systems:** Actuating systems, hydraulic systems, Classifications of Valves, Pressure relief valves, Pressure regulating/reducing valves, Cylinders and rotary actuators.	**8**

Course Outcomes: By the end of the course, the students should be able to: CO1: Classify various sensors, transducer and actuator according to the applications. CO2: Explain various control systems used in automation. CO3: Develop mechanical, hydraulic, pneumatic and electrical control systems. CO4: Explain various applications of design in mechatronic system.	
Question Paper Pattern: • The question paper will have ten full questions carrying equal marks. • Each full question will be for 20 marks. • There will be two full questions (with a maximum of four sub-questions) from each module. • Each full question will have sub-question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module.	
Textbooks: 1. Nitaigour Prem chandMahalik , Mechatronics-Principles, Concepts and Applications, Tata McGraw Hill, 1st Edition, 2003 ISBN.No. 0071239243,9780071239240. 2. W. Bolton-Pearson Education, Mechatronics – Electronic Control Systems in Mechanicaland Electrical Engineering, 1st Edition, 2005 ISBNNo.81-7758-284-4. **Reference Books:** 1.Mechatronics by HMT Ltd. – Tata McGrawHill, 1st Edition, 2000.ISBN:9780074636435. 2.Anthony Esposito, Fluid Power, Pearson Education, 6th Edition, 2011, ISBNNo.9789332518544.	

Course Code	18ME84	Course Title	Technical Seminar	Semester	VIII
Credits	2	L – T – P - TL*	0– 0 – 2 - 2	Teaching Hrs	
Total Marks	100	CIE*	--	SEE*	100
*NOTE: L – Lecture; T-Tutorial; P – Practical; TL – Total; CIE – Continuous Internal Evaluation; SEE – Semester End Examination					

Course Code	18MEPW85	Course Title	Project Phase-II	Semester	VIII
Credits	6	L – T – P- TL*	0– 0 – 18 - 18	Teaching Hrs	---
Total Marks	100	CIE*	40	SEE*	60
*NOTE: L – Lecture; T-Tutorial; P – Practical; TL – Total; CIE – Continuous Internal Evaluation; SEE – Semester End Examination					

Course Code	18ME86	Course Title	Internship	Semester	VIII
Credits	2	L – T – P - TL*	0– 0 – 6 - 6	Teaching Hrs	
Total Marks	100	CIE*	--	SEE*	100
*NOTE: L – Lecture; T-Tutorial; P – Practical; TL – Total; CIE – Continuous Internal Evaluation; SEE – Semester End Examination					