1st Semester:

Sl. No.	Course Code	Course Name	Category	L-T-P	Credit
1	HUL 1101	Communicative English	DC	2-0-0	2
2	MAL 1101	Engineering Mathematics I	DC	3-1-0	4
3	CHL 1101	Engineering Chemistry	DC	3-0-0	3
4	EEL 1101	Basic Electrical Engineering	DC	3-0-0	3
5	MEL 1101	Engineering Mechanics	DC	3-0-0	3
Practical					
1	EEP 1101	Basic Electrical Engineering Laboratory	DC	0-0-3	1.5
2	CHP 1101	Engineering Chemistry Laboratory	DC	0-0-3	1.5
3	MEP 1101	Engineering Mechanics Laboratory	DC	0-0-3	1.5
4	HUP 1101	Language Laboratory	DC	0-0-2	1
5	OBE 1101	Outcome Based Education	DC	1-0-0	AUDIT
	TOTAL			15-1-11	**20.5**

MEL 1101 Engineering Mechanics

1. Course Description:

Basic principles: Equivalent force system; Equations of equilibrium; Free body diagram; Reaction; Static indeterminacy. Structures: Difference between trusses, frames and beams, Assumptions followed in the analysis of structures; 2D truss; Method of joints; Method of section; Frame; Simple beam; types of loading and supports; Shear Force and bending Moment diagram in beams; Relation among load, shear force and bending moment. Friction: Dry friction; Description and applications of friction in wedges, thrust bearing (disk friction), belt, screw, journal bearing (Axle friction); Rolling resistance. Virtual work and Energy method: Virtual Displacement; Principle of virtual work; Applications of virtual work principle to machines; Mechanical efficiency; Work of a force/couple (springs etc.); Potential energy and equilibrium; Stability. Center of Gravity and Moment of Inertia: First and second moment of area; Radius of gyration; Parallel axis theorem; Product of inertia, Rotation of axes and principal moment of inertia; Moment of inertia of simple and composite bodies. Mass moment of inertia. Kinematics of Particles: Rectilinear motion; Curvilinear motion; Use of Cartesian, polar and spherical coordinate system; Relative and constrained motion; Space curvilinear motion. Kinetics of Particles: Force, mass and acceleration; Work and energy; Impulse and momentum; Impact problems; System of particles. Kinematics and Kinetics of Rigid Bodies: Translation; Fixed axis rotational; General plane motion; Coriolis acceleration; Work-energy; Power; Potential energy; Impulse-momentum andassociated conservation principles; Euler equations of motion and its application.

2. Pre-requisite:

Not Applicable

3. Broad Course Outline:

- Introduction
- Structure
- Truss and Frame
- Friction
- Virtual work and Energy
- COG and Moment of Inertia
- Kinematics of particle
- Kinetics of particle

4. Course Outcomes (COs):

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

- Know about basics of mechanics
- Know about the mechanics of load distribution in truss and frame
- Understand friction and its application
- Understand the kinematics and kinetics of particle
- Understand the kinematics and kinetics of rigid bodies
- Understand work, energy and momentum

5. Books:

Text Books

- Engineering Mechanics - Static and Dynamic, R.C. Hibbeler, Pearson Publication.
- Engineering Mechanics - Static J.L. Meriam et.al. Wiley India Pvt. Ltd.

Reference Books

- Engineering Mechanics - Dynamic J.L. Meriam et.al. Wiley India Pvt. Ltd.

2nd Semester:

Sl. No.	CourseCode	Course Name	Category	L-T-P	Credit
1	ECL 1201	Basic Electronics Engineering	DC	3-0-0	3
2	HUL 1202	Social Science	DC	2-0-0	2
3	MAL 1202	Engineering Mathematics II	DC	3-1-0	4
4	PHL 1201	Engineering Physics	DC	3-0-0	3
5	CSL 1201	Introduction to Computer Programming	DC	3-0-0	3
Practical					
1	MEP 1201	Engineering Drawing	DC	0-0-4	2
2	CSP 1201	Introduction to Computer Programming Laboratory	DC	0-0-3	1.5
3	PHP 1201	Physics Laboratory	DC	0-0-3	1.5
4	MEP 1202	Mechanical Workshop	DC	0-0-3	1.5
5	ECA 1201	Extracurricular Activity	DC	0-0-0	AUDIT
TOTAL				14-1-13	**21.5**

MEP 1101 Engineering Drawing

1. Course Description

Introduction: Importance of Engineering Drawing, General instruction, Lines, Lettering, Dimensioning, and freehand sketch. Geometrical construction and Scale: Bisecting a line, arc and angle, Dividing a straight line in to equal number of parts, Tangents to lines and arcs, Construction of pentagons and octagons, Inscribing circles inside regular polygons, Plane and Diagonal. Conic Sections: Type of conic surface, Method of construction of ellipse, Method of construction of parabola, Method of construction of hyperbola. Projection of point and straight line: Point Projection, Line parallel to both the reference planes, Line perpendicular to one reference plane and parallel to the other, Line inclined to one reference plane and parallel to the other, Line inclined to both the reference planes, True length and inclination, Traces of lines. Projection of plane: Plane perpendicular to both the reference planes, Plane perpendicular to one reference plane and parallel to the other. Plane inclined to one reference plane and perpendicular to the other, Plane inclined to both the reference plane. Projection of solids: Axis of solid parallel to both the reference planes, Axis of solid perpendicular to one reference plane and parallel to the other, Axis of solid inclined to both the reference planes. Sections of solids: Sectional view, section plane perpendicular to the HP & VP and other various positions, True shape of sections. Development of surface: The principle of development of surfaces, Methods for drawing the development of surfaces. Orthographic projection: Orthographic projection of different types of simple objects, Sectional view of different types of simple objects. Isometric projection: Principle of isometric projection, Isometric scale, Produced for drawing isometric projection, Isometric projection, and isometric view.

2. Prerequisite:

Engineering Mathematics- I (MAL 1101)

3. Broad Course Outlines

- Introduction
- Geometric construction and scale
- Conic Section
- Projection of points, lines, and planes
- Projection of solids
- Section of solids

4. Course Outcomes:

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

- Draw the geometric construction and scale
- Draw the ellipse, circle, parabola, and hyperbola, etc.
- Understand different sections and views of points, lines, and planes
- Visualize the different projections and views of solids
- Perform and understand the sectioning of solid

5. **Books:**

Text Books

- N.D. Bhatt et.al., Engineering Drawing, Charotor Publishing House.
- B. Agrawal et.al, Engineering Drawing, Tata Mc Graw Hill.

Reference Books

- Dhananjay A. Jolie, Engineering Drawing, Tata Mc Graw Hill.

यांत्रिक अभियांत्रिकी विभाग

Department of Mechanical Engineering

3rd Semester:

Course Structure

SL.No	Course code	Subject	Teaching Scheme			Credits
Theory			**L**	**T**	**P**	
1.	MEL1301	Material Science	3	0	0	3
2.	MEL1302	Fluid Mechanics- I	2	1	0	3
3.	MEL1303	Strength of Materials	2	1	0	3
4.	MEL1304	Basic Thermodynamics	2	1	0	3
5.	MAL1301	Numerical Methods	3	1	0	4
6	MEL1305	Machine Drawing	1	0	4	3
Practical						
7.	MEP1301	Fluid Mechanics Laboratory	0	0	2	1
8.	MEP1302	Strength of Materials Laboratory	0	0	2	1
					Total	**21**

MEL1301: MATERIAL SCIENCE

1. Course Description:

Concept of crystallographic planes and directions: Methods to determine the crystal structures, Atomic packing, and Crystal defects. Stability of phases and equilibrium: Phase transition, phase equilibrium diagrams, phase rule and equilibrium, cooling curves, solid solution equilibrium diagrams, iron-iron carbide equilibrium diagram. Kinetics of phase transformation: crystallization, nucleation, homogenous nucleation, heterogeneous nucleation, crystal growth, dendritic growth. Annealing, Normalizing, Spheroidizing, Quenching, Hardenability, Precipitation hardening, Time Temperature Transformation (TTT) diagram. Continuous Cooling Transformation (CCT) diagram and effect of alloying elements etc.

2. Pre-requisite:

Engineering Chemistry (CHL 1101)
Engineering Physics (PHL 1201)

3. Broad Course Outline:

- Structure of solids
- Phase transformations and phase equilibrium
- Rate processes and crystallization
- Rate processes and crystallization
- Heat treatment of steel
- Diffusion
- Mechanical Properties
- Electronic Properties
- Metals and Alloys

4. Course Outcomes (COs):

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

- Apply core concepts in Materials Science to solve engineering problems
- Interpret about material fundamental and material processing
- Distinguish the defects in crystal and its effect on crystal properties
- Figure out the different mechanical properties of material by studying different destructive and non- destructive testing
- Articulate and utilize corrosion prevention strategies and estimate the corrosion behaviour of materials and components

- Acknowledge the importance of surface modification and study the different surface modification methods
- Perceive the basics of Powder metallurgy and application of powder metallurgy
- Select proper metal, alloys, non-metal and powder metallurgical components for specific application requirements

5. Books:

Text Books

- K.M Gupta, Materials Science, Umesh Publication.
- V Raghvan, Material Science, Prentice Hall
- Narula, Material Science, Tata McGraw Hill
- Srivastava & Srinivasan, Science of Materials Engineering, New Age Publication

Reference Books

- W.D Callister, Material Science & Engineering, Addition-Wesley Publication
- Vlack Van, Elements of Material Science & Engineering, John Wiley & Sons
- Avner, Introduction to Physical Metallurgy, Tata McGraw Hill.

MEL1302: Fluid Mechanics- I

1. Course Description:

Introduction: Definition of fluid, continuum hypothesis, different properties of the fluid, classification of fluids. Fluid Statics: pressure at a point, Pascal's law, variation of pressure within a static fluid –equation of hydrostatic pressure distribution, buoyancy, stability of submerged and floating bodies. Fluid Kinematics: preliminaries of Eulerian and Lagrangian description of fluid flow, velocity, and acceleration of fluid particles in rectilinear and curvilinear co-ordinates; different types of flow, principle of conservation of mass – equation of continuity for a stream tube and unsteady three-dimensional flow, deformation of a fluid particle–linear and angular deformation and rotation, vortex motion, relative equilibrium of fluids. Fluid Dynamics: principle of conservation of linear momentum, Euler's equation of motion along a streamline and for unsteady three-dimensional flow, derivation of Bernoulli's equation and physical significance of different terms, applications of Bernoulli's equation in flow measurement devices: stagnation tube, pitot tube, venturi meter, orifice meter. Application of Linear and Angular Momentum equation: linear momentum equation, analysis of force exerted by a fluid stream on a solid boundary. Principle of Conservation of Angular Momentum and its application. Steady Flow Energy Equation and its application. Characteristics of Laminar and Turbulent Flow: Reynolds experiment, critical Reynolds number, laminar flow through a pipe – Hagen Poiseuille equation. Flow Through Closed Conduits: Darcy Weisbach equation, the friction factor of closed conduits, flow through noncircular ducts, Moody's diagram and its use, losses in pipes, and analysis of simple pipe network problems. Free surface flow: Flow in an open channel, Chezy's equation etc.

2. Pre-requisite:

Engineering Mechanics (MEL 1101)
Engineering Physics (PHL 1101)
Engineering Mathematics-I (MAL 1101)

3. Course Outcomes (COs):

Upon the completion of this course, the students are expected to:

- Describe the basic concepts of fluid mechanics and recognize the various types of fluid flow problems encountered in practice.
- Determine the variation of pressure in a fluid at rest and also calculate the forces exerted by a fluid at rest on a plane or curved submerged surfaces.

- Apply the role of material derivative in transforming between Lagrangian and Eulerian descriptions, and explain the four fundamental kinematic properties of fluid motion and deformation.
- Derive and apply various conservative equations related to fluid flow problems.
- Develop a fundamental understanding of the techniques of numerical solutions of fluid flow problems.

4. Broad course outline:

- Introduction
- Fluid Statics
- Fluid Kinematics
- Fluid Dynamics
- Laminar and Turbulent Flows

5. Study Materials:

Text Books:

- S.K. Som, G. Biswas and S. Chakraborty. Introduction to Fluid Mechanics and Fluid. Tata McGraw Hill.
- Cengel and Cimbala, Fluid Mechanics. Tata McGraw Hill.

Reference Books:

- R.W. Fox, P.J. Pritchard, and A. T. McDonald. Introduction to Fluid Mechanics. Wiley.
- Frank M. White. Fluid Mechanics. McGraw Hill.
- A. K. Jain. Fluid Mechanics. Khanna Publishers.

MEL 1303: Strength of Materials

1. Course Description:

Concept of stress and strain: Types and definition, Hook's law, Principle of superposition, Plane stress, principle planes, principle stresses and maximum shear stresses, Mohr's circle for plane stress, tri-axial stress, Elastic constants, Bars of the varying section, Indeterminate structures, Thermal stresses, Strain energy; Theories of elastic failure: Types, Definition, Graphical representation; Pure Bending: Stresses in Beams, Beam of uniform strength, Direct shear stresses in beams; Torsion of Circular shafts: Stress and strain in pure shear, Statically indeterminate torsional member, Strain energy in torsion; Slope and Deflection of Statically Determinate Beams and statically Indeterminate Beams Under Different Types of Loads. Column and Struts: Euler's Theory of Buckling of Columns, End conditions for columns, Empirical formulae for columns. Thick and Thin Cylinders: Stresses and Strains in thin and thick cylinders and spheres subjected to internal and external pressures.

2. Pre-requisite:

Engineering Mechanics (MEL 1101)
Material Science (PHL 1101)

3. Course Outcomes (COs):

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

- Predict the mechanical behaviour of the member by determining the stresses, strains and deflections produced by the loads up to the elastic limit
- Solve the stresses in determinate and indeterminate, homogeneous and composite bars under concentrated loads, self-weight, and thermal loads
- Determine bending and shear stresses in machine elements
- Evaluate the Slope and Deflection of Statically Determinate beams
- Estimate stresses, strain, and deformations in homogeneous and composite, solid and hollow circular shafts, subjected to twisting moment
- Estimate the critical load of columns under various end conditions.

4. Broad course outline:

- Stress and Strain
- Theories of Elastic failures
- Simple Bending of Beams
- Slope and Deflection of Beams
- Columns

- Pressure Vessels

5. Books:

Text Books

- Beer and Johnson, Mechanics of Material, McGraw Hill Publication
- B. John Goodno & M. Gere James, Mechanics of materials, Cenage Learning
- G.H Ryder, Strength of Materials, Palgrave Macmillan Publishers
- S. S. Rattan, Strength of Materials, Tata McGraw Hill Publication

Reference Books

- L.S Srinath, Mechanics of Solids, Tata McGraw Hill Publication
- S. Timoshenko, Strength of Materials- Part 1, CBS Publishers
- A. Pytel and F.L Singer, Strength of Materials, Longman

MEL 1304: Basic Thermodynamics

1. Course Description:

Introduction: Macroscopic and microscopic concepts, System and its classification. Thermodynamic State: Properties, Processes and Cycles, Thermodynamic Equilibrium, Concept of Temperature, Temperature Scale, Energy interactions. First law of thermodynamics, Concepts of internal energy, Enthalpy, Specific heats, PMMI, Energy equations for flow systems, and Application of energy equations to different engineering components. Second Law of thermodynamics: Preliminary definitions, Different statements and their equivalence, Reversibility and irreversibility, Causes of irreversibility, reversible cycles, Carnot theorem, Absolute thermodynamic temperature scale. Third law of thermodynamics: Clausius theorem and inequality, Entropy and disorder, Evaluation of entropy change during various processes, T-S and H-S diagrams. Gases-Equation of state of an Ideal Gas, Specific heat, Internal Energy, Enthalpy, and Entropy change of Ideal Gases, Equation of state of Real Gases, Principle of the corresponding state, Compressibility Factor. Definition of Sensible Heat, Latent Heat, Saturation Temperature, Quality, Evaluation of Properties from Steam Table and Mollier Diagram.

2. Pre-requisite:

Engineering Chemistry (CHL 1101)
Engineering Physics (PHL 1101)

3. Course Outcomes (COs):

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

- explain the basic principles and applications of the thermody0mics to the various real life systems
- describe fundamental laws of thermodynamics
- apply the concepts such as Entropy, Energy Balance also the calculations of heat, work and other important thermodynamic properties for various ideal gas processes. estimate performance of various thermody0mic gas power cycles and gas refrigeration cycle and availability in each case
- examine the condition of steam and performance of the vapour power cycle and vapour compression cycle.
- understand Stoichiometric air required for combustion, performance of steam generators and natural draught requirements in boiler plants.
- use Psychometric charts and estimate various essential properties related to Psychrometry and processes

4. Broad course outline:

- Concepts of Thermodynamics
- First Law of Thermodynamics
- Second Law of Thermodynamics
- Entropy
- Properties of Substances

5. Study Materials:

Text Books

- P. K Nag, Engineering Thermodynamics, TMH, India
- R Yadav, Thermodynamics and Heat Engines, Vol I & II, Central Publishing House Allahabad

Reference Books

- G. J. V. Wylen, R. E. Sonntag, C. Borgnakke, Fundamentals of classical thermodynamics: John Wiley & Sons.
- Wark Wenneth, Thermodynamics, McGraw Hill.
- R Joel, Basic Engineering Thermodynamics, Addison Wesley

MEL 1305: Machine Drawing

1. Course Description:

Principle of the first angle and third angle projection. ISI conventions in drawing surface finish, limits, fits, and tolerance. Introduction of drafting software like AutoCAD, SolidWorks, etc., Orthographic projection, and sectional views of different types of composite bodies. Fasteners: thread nomenclature, forms of thread, thread series, designation and representation of threads, bolted joints, locking arrangements of nuts, and foundation bolts. Types of keys. Cotter and knuckle joint. Rigid and flexible coupling. Types of rivet heads and riveted joints. Assembly drawing: I.C. engine components, valves, machine tools, etc. Basic 3D modeling practice of simple machine elements using AutoCAD, SolidWorks, etc.

2. Pre-requisites:

Engineering Drawing (MEP 1201)

3. Course Outcome:

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

- Read and interpret a given production drawing.
- Understand the type of fit and tolerances used in the assembly of machine components.
- Explain the terminology of screw thread
- Explain standard forms of thread with empirical relations.
- Differentiate between bolted and riveted joints.
- Draw the different views of various types of couplings showing sectional details in any of the views
- Comprehend the sectional view of the assembly of machine components.
- Differentiate between free sketching and machine drawing.
- Create 2-D and 3-D models with standard CAD software with manufacturing considerations.

4. Broad Course Outline:

- Orthographic Projections
- Limits and Fits
- Screwed fasteners
- Keys, Cotter Joint and Pin joint
- Shaft Couplings
- Riveted joints
- Assembly Drawing

- Computer Aided Drafting

5. Study Materials:

Text Books:

- N. D. Bhatt, Machine Drawing, Charotar Publishing House Pvt. Ltd.
- Ajeet Singh, Machine Drawing, Tata McGraw Hill Education Pvt. Ltd.
- K.L. Narayana, P. Kannaiah & K. Venkata Reddy: Production Drawing, New Age International Publisher.

Reference Books:

- R.K. Dhawan, A Text Book of Machine Drawing, S. Chand & Co Ltd.
- N. Sidheswar, P. Kannaiah and V.V.S. Sastry, Machine Drawing, Tata McGraw Hill Education Pvt. Ltd.

MEP 1301: Fluid Mechanics Laboratory

List of Experiments:

- Measurement of viscosity
- Study of Pressure Measuring Devices
- Stability of Floating Body
- Hydrostatics Force on Flat Surfaces/Curved Surfaces
- Verification of Bernoulli's Theorem
- Venturi meter
- Orifice meter
- Flow Visualization -Ideal Flow
- Length of the establishment of flow
- Velocity distribution in pipes

MEP 1302: Strength of Materials Laboratory

List of experiments:

- To study the Brinell hardness testing machine and the Brinell hardness test
- To study the Rockwell Hardness testing machine and perform the Rockwell hardness test
- To study the Impact Testing machine and Perform the Izod impact test
- To study the Impact Testing machine and Perform the Charpy impact test
- To study the UTM and perform the tensile test for a ductile material.
- To study the UTM and perform the tensile test for a Brittle material.
- To perform Torsion test on a mild steel rod

यांत्रिक अभियांत्रिकी विभाग

Department of Mechanical Engineering

4th Semester

Course Structure

SL.No	Course code	Subject	Teaching Scheme			Credits
Theory			**L**	**T**	**P**	
1.	MAL1401	Numerical Method and Probability Theory	3	1	0	4
2.	MEL1401	Kinematics of Machine	2	1	0	3
3.	MEL1402	Fluid Mechanics- II	2	1	0	3
4.	MEL1403	Applied Thermodynamics	2	1	0	3
5.	MEL1404	Advanced Solid Mechanics	2	1	0	3
6.	MEL1405	Manufacturing Science and Technology	3	0	0	3
Practical						
7.	MEP1401	Kinematics of Machine Laboratory	0	0	2	1
8.	MEP1402	Fluid Machinery Laboratory	0	0	2	1
9.	MEP1403	Manufacturing Laboratory- I	0	0	2	1
					Total	**22**

MAL1401: Numerical Method and Probability Theory

1. Course Description:

Introduction: Basic numerical analysis, probability study, and its engineering application, Solutions of algebraic and transcendental equations by the Iteration method, Newton-Raphson method and their convergence, Solutions of linear equations by Gauss elimination method, Gauss-Seidel method, LU decomposition method, Newton- Raphson method. Solution of nonlinear equations by Taylor's series method, Euler's modified method, Runge-Kutta method, Adam's Bashforth method, Adam's Moulton method, and Milne's predictor-corrector method. Random variables: Discrete and continuous random variables, probability density function, probability distribution function, definition of mathematical expectation, functions of random variables, variance, standard deviations, moment generating function central tendency and dispersion, skewness, and kurtosis, Binomial distribution, Poisson distribution, Normal distribution, Random processes: continuous and discrete, determinism, stationarity, ergodicity, etc., Correlation functions: Auto-correlation and Cross-correlation, properties and applications of correlation functions.

2. Course Outcomes (COs):

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

1. understand the basic numerical analysis
2. understand the basic importance of numerical methods to tackle problems that cannot be solved analytically
3. know about various methods of numerical analysis, viz. Newton-Raphson method, Gauss-Seidel method
4. know about Taylor's series, Euler's method
5. Become familiar with numerical interpolation and approximation of functions.

3. Pre-requisite:

Engineering Mathematics I (MAL 1101)
Engineering Mathematics II (MAL 1201)

4. Broad Course Outline

- Numerical Analysis
- Numerical solution of ordinary differential equations
- Probability theory

5. Study Materials:

Text Books

- R K Iyengar & S R K Iyengar, Numerical Methods, New Age International Publishers
- V.K. Rohatgi and A.K.M. Ehsanes Sateh: An Introduction to Probability and Statistics, John Wiley & Sons.
- Spiegel, M.R., Theory and problems of Probability and Statistics, McGraw-Hill.

Reference Books

- S. D. Conte and Carl de Boor, Elementary Numerical Analysis: an algorithmic approach, McGraw-Hill, Asia.
- Gerald and Wheatley, Applied Numerical Analysis, Addison-Wesley.

MEL1401: Kinematics of Machines

1. Course Description:

Introduction: Links & their types, kinematics pairs and their classification, constraints & their types, Degree of freedom, Grubler's and Kutzbach's Criterion. Linkage Mechanisms: Grashoff's Law, inversions of four links mechanism. Velocity and acceleration analysis: Relative Velocity Method, Instantaneous Point in Mechanism, Kennedy's theorem, velocity & acceleration diagram, Coriolis component of acceleration, Klein's Construction for slider crank and four bar mechanism. Graphical Methods of Synthesis: Two and three-position synthesis of four-bar and slider crank mechanisms, Pantograph. Cams and Followers: Terminologies and classifications, cam profile by graphical methods, analytical cam design. Gears: Terminologies and classifications, law of gearing, ooth forms, interference, under cutting, the minimum number of teeth on gear and pinion to avoid interference. Gear train: Classifications and applications.

2. Course Outcomes (COs):

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

- Understand the degree of freedom, linkage mechanism, and other inversions.
- Understand the commonly used mechanism for industrial application.
- Determine the velocity and acceleration of different mechanisms.
- Get competency in drawing velocity and acceleration diagrams for simple and complex mechanisms.
- Understand Cam and Follower mechanism
- Understand in detail about gears and gear trains

3. Pre-requisite:

Engineer Mechanics (MEL 1101)

4. Broad Course Outline:

- Introduction to linkage and mechanism
- Analysis of velocity and acceleration of Mechanisms
- Kinematics Synthesis of Planar Linkages
- Cams and followers
- Gears and gear trains

5. Study Materials:

Text Books

- J J. Uicker Jr., G. R. Pennock & J E. Shigley, Theory of Machines and Mechanisms, Oxford University Press
- S. S. Rattan, Theory of Machines, Tata McGraw Hill.
- Ghosh & Mallik, Theory of Machines and Mechanisms, East west press.

Reference Books

- R. K Bansal, A Text Book of Theory of Machines, Laxmi Publishers.
- Khurmi & Gupta, Theory of Machines: S. Chand and Company Ltd., New Delhi.
- Rao & Dukkipati, Mechanism and Machine Theory, John Wiley & Sons.

MEL1402: Fluid Mechanics- II

1. Course Description:

Introduction: Basic concept of turbulence and turbulent flow. Equation of motion for viscous flow: Two-dimensional laminar flow between flat parallel plates and annulus. Boundary Layer Theory: Concept of the boundary layer, boundary layer thickness, displacement thickness, momentum thickness, growth of boundary layer, Prandtl's boundary layer equations, Von Karman's momentum integral equation for a boundary layer, skin friction drag coefficient for the laminar and turbulent boundary layer, hydraulically smooth and rough surfaces, boundary layer in pipe flow, friction velocity, separation of the boundary layer, form drag, method of drag reduction, lift and drag on submerged bodies, aerofoils, stalling of aerofoils. Compressible Flow: Review of thermodynamic principles for perfect gases, adiabatic and isentropic relations, steady flow energy equation, the speed of propagation of a small disturbance through a compressible fluid, sonic velocity, Mach number, Mach cone and Mach wave, isentropic flow, stagnation properties of a compressible flow, isentropic pressure, temperature and density ratios, compressibility correction factor in the measurement of airspeed, area – velocity relationship for compressible flow through a variable area duct, the mass flow rate through a duct, critical condition and choking, flow through the convergent-divergent nozzle, over expansion and under expansion, the performance of propulsive nozzles, normal shock, normal shock relations, wave drag. Dimensional analysis: Dimensional analysis and Buckingham Pi theorem, similarity and model studies. Unsteady flow – water hammer. Principles of Fluid Machines: Introduction, classification of fluid machines, hydraulic turbines and pumps.

2. Pre-requisite:

Fluid Mechanics- I (MEL 1302)

3. Course Outcomes (COs):

Upon the completion of this course, the students are expected to:

- Gain a basic understanding of boundary layer theory for various practical applications of fluid flow in various regimes.
- Understand ideal fluid flow, compressible fluid flow, and its applications.
- Learn the principle of dimensional analysis.
- Get a basic understating of unsteady flow and its application in water hammer.
- Gain basic knowledge of fluid machinery and its components.

4. Broad course outline:

- Introduction
- Boundary Layer Theory
- Compressible flow
- Dimensional Analysis
- Principle of Fluid Machines

5. Study Materials:

Text Books:

- S. K. Som, G. Biswas and S. Chakraborty, Introduction to Fluid Mechanics and Fluid. Tata McGraw Hill.
- Cengel and Cimbala, Fluid Mechanics, Tata McGraw Hill.
- J. D. Anderson, Modern Compressible Flow, McGraw Hill.

Reference Books:

- R.W. Fox, P.J. Pritchard and A. T. McDonald, Introduction to Fluid Mechanics. Wiley.
- Frank M. White, Fluid Mechanics, McGraw Hill.
- A. K. Jain, Fluid Mechanics, Khanna Publishers.
- G.K. Batchelor, An Introduction to Fluid Dynamics, Cambridge University Press.

MEL1403: Applied Thermodynamics

1. Course Description:

Introduction: Concept of Maxwell relation, specific heat relations, relations for changes in internal energy, enthalpy and entropy, Clapeyron equation, Joule-Thomson coefficient, generalized relations, and charts for residual enthalpy and entropy. IC engines: Types and cycles, engine components, working principle of 2-stroke and 4-stroke engines, valve timing diagrams, engine performance parameters. Gas Turbine: classification, air-standard cycle, Stirling, Ericsson cycles, Carnot cycle, Rankine cycle, actual vapour power cycle processes, reheat cycle, regenerative cycle, feed water heaters (open and closed), characteristics of an ideal working fluid in vapour power cycle, binary vapour cycles, thermodynamics of combined cycles. Single stage and multistage air compressors, work done per cycle, compressor capacity, power calculation, volumetric efficiency and isothermal efficiency, Effect of clearance ratio on volumetric efficiency, intercooler and after cooler. Fuels and combustion: Theoretical and actual combustion processes, enthalpy of formation and enthalpy of combustion, first law analysis of reacting systems, adiabatic flame temperature, entropy change of reacting systems, second law analysis of reacting systems. Refrigeration cycles: vapour compression refrigeration, vapour absorption refrigeration, types of refrigerants and properties of ideal refrigerants. Psychometry: Psychometric properties and processes, psychometric chart.

2. Pre-requisite subjects:

Basics Thermodynamics (MEL1304)
Basics of Fluid Mechanics (MEL1302)
Engineering Mathematics (MAL1202)

3. Course Outcome:

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

- Understand enthalpy, entropy, and various important equations
- Understand the IC engine
- Understand the working of 2-stroke, 4 stroke
- Gain knowledge about the Carnot cycle, Rankine cycle, and other steam cycles
- Know about fuels, combustion processes
- Understand Refrigeration Cycles and Psychrometric processes

4. Broad Course Outline:

- Thermodynamic property relations
- Gas Power Cycle
- Vapour power cycle
- Reciprocating air compressor
- Combustion processes

- Refrigeration and Psychometry

5. Study Materials:

Text Books

- R.K Rajput, Thermal Engineering, Dhanpat Rai & Sons.
- R Yadav, Steam & Gas turbines and Power Plant Engineering, Central Publishing House Allahabad.

Reference Books

- P.K Nag, Basic and Applied Thermodynamics, TMH Publication New Delhi.
- Yunus A. Cengel. And Michael A. Boles, Thermodynamics , An Engineering Approach: Mcgraw Hill Education.

MEL1404: Advanced Solid Mechanics

1. Course Description:

Analysis of Stress in 3D: State of stress at a point, Cauchy's formula, principal stresses, stress invariants, 3D Mohr's circle, octahedral stresses, hydrostatic and pure shear stresses, differential equations of equilibrium in rectangular and polar coordinates. Analysis of Strain in 3D: state of strain at a point, principal strains, strain deviators and invariants, compatibility conditions in rectangular and polar coordinates, constitutive relations. Bending of beams: Symmetric and asymmetric bending, shear center, bending of curved beams. Torsion: Torsion in general prismatic bar and thin-walled tube, Center of twist. Analysis of beam-columns, Yield and Fracture criteria, Energy Methods: Principle of virtual work, Minimum potential energy, Stress formulation and displacement formulation, Methods of solution and uniqueness of the solution.

2. Course Outcomes (COs):

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

- Understand stress and strain in 3D
- Understand symmetric and asymmetric bending
- Understand torsion in non-circular bars
- Understand the principle of virtual work and its formulation

3. Pre-requisite:

Strength of Material (MEL 1303)

4. Broad Course Outline:

- Analysis of stresses
- Analysis of strains
- Bending of beams
- Torsion of non-circular bars
- Elastic stability
- Energy methods

5. Study Materials:

Text Books

- L.S. Srinath, Advanced Mechanics of solids, Tata McGraw Hill.
- Beer & Johnston, Mechanics of Materials, McGraw Hill Education.
- Roy R. Craig, Jr, Mechanics of Materials, Wiley Publication.

Reference Books

- Krishnaswamy, Kulkarni & Gharpure, Advanced Strength of Materials, Khanna Publishers.
- E. P. Popov, Mechanics of Materials, Pearson Education.
- N. Krishna Raju, Mechanics of Solids & Structures, McGraw Hill Education.

MEL1405: Manufacturing Science and Technology

1. Course Description:

Introduction: Importance of manufacturing, classification, and their applications. Casting: Moulding parameters and design, types of pattern and allowances, solidification of casting, gating system design, types of casting processes, sand preparation and testing methods, foundry furnaces, casting defects, and remedies. Metal forming: Principle of deformation, hot and cold working, description and analysis of different forming processes, metal forming Defects. Welding and joining: Types and classification, Gas welding, Resistance welding, Arc Welding (formation of arc and its characteristics, theory of heat generation, power source selection, different arc welding processes, welding consumables), Soldering, Brazing, Braze welding, and solid-state welding, metallurgical characterization of weldment, welding defects, and inspection. Concept of powder metallurgy and its applications. Introduction to additive manufacturing and its classification.

2. Pre-requisite:

Material Science (MEL1301)
Fluid Mechanics (MEL1302)
Strength of Materials (MEL1303)

3. Course Outcome (COs):

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

- Know about basic classification and the importance of different manufacturing processes.
- Understand the basics of casting, mould design, and it's variations, including casting defect mitigation.
- Know about the physical principles of different forming processes selection of proper forming processes.
- Understand the basic principles of different welding processes and selection of proper welding method.
- Understand the process of making an object of net shape from loose mass of powder.
- Basic technical understanding of the physical principles, materials, and operation of the types of AM processes.

4. Broad Course Outline:

- Introduction
- Casting
- Forming
- Welding

- Powder metallurgy
- Additive manufacturing

5. Study Materials:

Text Books:

- Ghosh and Malik, Manufacturing science, East West Pvt. Ltd.
- Rao, P.N., Manufacturing Technology, Volume 1, McGraw-Hill Education, New Delhi.

Reference Books:

- J.S. Campbell, Principles of Manufacturing Materials and Processes, Tata McGraw Hill.
- M. C. Flemings, Solidification Processing, Tata McGraw Hill.
- DeGarmo, Materials & Manufacturing, Wiley Publications.
- S. Kalpakjian , S. Schmid, Manufacturing Engineering & Technology, Pearson.
- Dr. R.S. Parmar , Welding Processes and Technology, Khanna Publishers.

MEP1401: Kinematics of Machine Laboratory

List of Experiments:

- Study of Simple Linkage Models
- Study of different mechanisms models
- Verification of Grashoff's Criteria for Four-Bar Linkages.
- Determination of Velocity Ratio and Verification of Holding torque in Epicyclic Gear Trains.
- Development of Displacement Curves of Cam and Determination of Jumping Speeds.
- Determination of Carioles Component of Acceleration Using Hydraulic Analogy.

MEP1402: Fluid Machinery Laboratory

List of Experiments:

- Demonstration of the Working Principle of the Runner of Pelton Wheel, Francis Turbine and Kaplan Turbine.
- Efficiency and Performance Characteristics Curve of the Pelton Turbine.
- Efficiency and Performance Characteristics Curve of Francis Turbine.
- Efficiency and Performance Characteristics Curve of Kaplan Turbine.
- Performance Characteristics of a Centrifugal Pump and to find Its Specific Speed and Efficiency.
- Performance Characteristics of a Reciprocating Pump and to find the Slip.

MEP1403: Manufacturing Laboratory-I

List of experiments:

- To perform and study the MMAW process to prepare different weld joints.
- To perform and study TIG and MIG welding processes to prepare different weld joints.
- Preparation of workpiece material and demonstration of the solid-state welding process.
- Determine the mould sand properties by different testing procedures.
- Preparation of green sand mould and casting of simple shape.
- Preparation of different cross-sectional shapes by forging operation.
- Manufacturing of sheet metal components using shearing and bending operations.

यांत्रिक अभियांत्रिकी विभाग

Department of Mechanical Engineering

5th Semester:

Course Structure

SL.No	Course code	Subject	Teaching Scheme			Credits
Theory			**L**	**T**	**P**	
1.	MEL1501	Heat Transfer	2	1	0	3
2.	MEL1502	Machining Technology and Metrology	3	0	0	3
3.	MEL1503	Dynamics of Machines	2	1	0	3
4.	MEL1504	Machine Design– I	2	1	0	3
5.	MEL 1505	Industrial Engineering and Management	3	0	0	3
6.	MEL1506	Sustainable Engineering	3	0	0	3
Practical						
7.	MEP1501	Heat Transfer Laboratory	0	0	2	1
8.	MEP1502	Manufacturing Laboratory- II	0	0	2	1
9.	MEP1503	Dynamics of Machines Laboratory	0	0	2	1
					Total	**21**

MEL1501: Heat Transfer

1. Course Description:

Introduction: One- dimensional heat conduction equation for slab, cylinder, sphere and composite medium, concept of critical thickness of insulation. Numerical methods: heat conduction problems. Analysis of steady-state heat transfer for fins of uniform cross-section, Fin performance. Radiation: Nature of thermal radiation, Radiative properties, Kirchhoff's law, Black body radiation intensity and total emissive power, Displacement law, Radiation heat transfer between black/grey surfaces, network method of solving radiation problems, Concept of view factor. Dimensional Analysis: Free and forced convection, thermal boundary layer, Equations of motion and energy, Empirical equations of convective heat transfer, Reynolds analogy, Heat transfer in boiling and condensation. Heat exchanger: Types, LMTD and NTU method of heat exchanger analysis. Computational studies in heat transfer processes in Conduction, Convection, and Radiation. Experimental techniques related to heat transfer analysis.

2. Pre-requisite Subjects:

Basics of Engineering Mathematics (MAL1301)
Engineering Physics (PHL1201)
Basics of Fluid Mechanics (MEL1302)

3. Course Outcomes:

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

- Comprehend the different modes of heat transfer and develop heat transfer equipment as per need.
- Formulate basic equations and Laws for heat transfer problems.
- Design and calculate the performance of thermal systems related to one-dimensional, steady state, and transient state for conduction and convection heat transfer
- Calculate and execute the impact of boundary conditions on the solutions of heat transfer in conduction and convection problems like extended surfaces (Fins)
- Determine the performance of thermal systems related to one-dimensional, natural, and Forced Convection heat transfer by Theoretically and Experimentally.
- Deal with heat transfer configurations for radiation between objects with simple geometries

- Implement the knowledge acquired to evaluate the effectiveness and rating of heat exchangers for single and multiphase phenomena.

4. Broad Course Outline:

- Conduction Heat Transfer
- Transfer For Extended Surfaces
- Radiation Heat Transfer
- Convection
- Heat Exchangers

5. Study Materials:

Text Books

- R Yadav, Heat Transfer, Central Publishing House, Allahabad.
- R.K Rajpoot, Heat and Mass Transfer, S. Chand
- D.S.Kumar, Heat and Mass Transfer, S.K Kataria & sons
- Y.V.C Rao, Heat Transfer, University Press

Reference Books

- Bayazitouglu & Ozisik, Elements of Heat transfer, T.M.H
- J.P Holman, Heat Transfer, McGraw-Hill International edition
- Pitts & Sisson, Schaum's outline of Heat Transfer, McGraw-Hill International edition
- Frank Kreith, Principles of Heat Transfer, McGraw-Hill Book

MEL1502: Machining Technology and Metrology

1. Course Description:

Mechanics of metal cutting, tool geometry and nomenclature (Tool in hand system, ASA system, ORS system), mechanics of chip formation, types of chips, Merchant's circle analysis, cutting forces, power required, tool temperature, tool material, tool wear, tool life, cutting fluid, and machinability. Machine tools: Working principle, construction, and operations of lathe, shaper, planer, slotter, milling, and drilling machines; dividing head and indexing. Grinding wheel, abrasive & bonds, grinding wheel specifications, grinding wheel wear, dressing & truing, surface grinding, cylindrical grinding, and centerless grinding. Super-finishing process: honing, lapping, etc. Tooling: Jigs and fixtures, principles of location, and clamping.

Metrology: Precision, accuracy, and sensitivity of measuring instruments, line, and end standards of measurement. Concept of interchangeability, limits, fits, and tolerances, limit gauges, Taylor's principle. Angular measurement: Comparators, measurement of lengths, angles, and tapers. Optical flat- principle and applications. Measurement of elements of threads and gears. Coordinate measuring machine. Assessment of surface roughness- the various parameters and measurement principles. Introduction to laser metrology.

2. Pre-requisite:

MEL1101 (Engineering Mechanics)

PHL1201 (Engineering Physics)

MEL1405 (Manufacturing Science and Technology).

3. Course Outcomes (COs):

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

- Explain the different tool nomenclature systems, mechanics of metal cutting, cutting tool materials, tool wear, and cutting fluids.
- Discuss the constructional feature of different types of lathe and their operations.
- Describe the construction & working of shaping, milling & drilling machines and gear cutting & finishing process.
- Illustrate the various types of grinding machines and broaching machines.

- Apply knowledge of various tools and techniques used to determine geometry and dimensions of components in engineering applications.
- Design gauges to meet desired needs within realistic constraints.

4. Broad Course Outline:

- Machining
- Machine tools
- Grinding
- Limit, fits and tolerance
- Measuring instruments
- Surface inspection

5. Study Materials:

Text Books:

• P. N. Rao, Manufacturing Technology Vol 2- Metal Cutting and Machine Tools, Tata McGraw Hill.
• A. Ghosh A. K. Mallik, Manufacturing Science, East-West Press Pvt. Ltd.
• S K Hajra Choudhury, Workshop Technology Vol II Machine Tools: Media Promoters & Publishers Pvt. Ltd.
• A. Bewoor, V. Kulkarni, Metrology & Measurement, McGraw-Hill Publishers.

Reference Books:

• G. Boothroyd and W. A. Knight, Fundamentals of Machining and Machine Tools, CRC Press,Taylor & Francis Group.
• H. Gerling, All About Machine Tools, New Age Int. (P) Ltd.
• B. S. Raghuwanshi, A Course in Workshop Technology Vol II (Machine Tools), Dhanpat Rai & Co.
• M. Mahajan, A textbook of metrology, Dhanpat Rai and Co.

MEL1503: Dynamics of Machines

1. Course Description:

Introduction; Static Force Analysis: Two/three force members, Static Force Analysis of Linkages, D'alembert's principle, Equivalent offset inertia force, Dynamic Force Analysis: Four Link Mechanism and Slider Crank Mechanism; Engine Force Analysis, Turning Moment on Crankshaft, Turning moment diagrams, Fluctuation of energy, Flywheel; Static and Dynamic Balancing: Balancing of Several Masses in the Same Plane and Different Planes, Balancing of Reciprocating Masses; Governor: Terminology, Types of Governor, Sensitivity, Stability, Hunting, Isochronism, Effort and Power of Governor, Controlling Force Diagrams for Governors; Clutch: Uniform Pressure and Uniform Wear theories, Frictional and Centrifugal Clutches; Belt and Pulley Drive: Length of Open and Cross Belt Drive, Ratio of Driving Tensions for Flat Belt Drive, Centrifugal Tension, Condition for Maximum Power Transmission, V Belt Drive; Brakes: Shoe Brake, Band Brake, Band and Block Brake; Gyroscope: Gyroscopic Torque, Effect of Gyroscopic Couple on the Stability of Two Wheeler and Four Wheeler, Ships and Aero-Planes. Mechanical vibration: Types of Vibrations, Single Degree Free, Damped, Forced, Forced & Damped Vibrations, System Under Harmonic Excitation, Critical Speeds of Shaft.

2. Course Outcomes (COs):

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

- Explain the force-motion relationship in components subjected to external forces and analysis of standard mechanisms.
- Explain the undesirable effects of unbalances resulting from prescribed motions in the mechanism.
- Calculate the natural frequencies for undamped and damped vibrating systems.
- Solve the problem of the effect of Dynamics of undesirable vibrations.
- Explain the principles in mechanisms used for speed control and stability control.

3. Pre-requisite:

Kinematics of Machine (MEL 1401)

4. Broad Course Outline:

- Static & Dynamic Force Analysis
- Turning Moment & Flywheel

- Balancing of Rotating and Reciprocating Masses
- Governors
- Friction
- Clutches & Brakes
- Gyroscope
- Mechanical Vibrations

4. Study Materials:

Text Books:

- Norton, Kinematics and Dynamics of Machinery, Mc Graw-Hill
- S. S.Rattan, Theory of Machines, Mc Graw-Hill
- J. S. Rao & R.V. Dukkipati, Mechanism & Machine Theory, New Age International Publication

Reference Books:

- A.Ghosh & A.K. Mallick, Theory of Mechanisms & Machines, Affiliated East West Press Pvt Ltd
- Kenneth J. Waldron and Gary L. Kinzel, Kinematics, Dynamics and Design of Machinery, Wiley India

MEL1504: Machine Design-I

1. Course Description:

Introduction: Definition, design requirements, design considerations, design procedure, standards in design, selection of preferred sizes, Indian Standards designation of carbon & alloy steels, selection of materials for static and fatigue loads. Design for static load: Modes of failure, factor of safety, principal stresses, stresses due to bending and torsion, theories of failure. Design for fluctuating loads: Cyclic stresses, fatigue and endurance limit, stress concentration factor, notch sensitivity, design for finite and infinite Life, Soderberg, Goodman and Gerber criteria. Riveted joints: Riveting methods, materials, types of rivet heads, types of riveted joints, Caulking and Fullering, failure of riveted joints, boiler joints, eccentrically loaded riveted joint. Threaded joint: Types, modes of failure, stresses due to axial and eccentric loading, torque requirement for bolt tightening. Welded joint: Types of welded joints, welding symbols, stresses in Butt and Fillet welds, unsymmetrical welds, welds subjected to eccentric loading. Shafts: Cause of failure, materials, stresses in shafts, design for strength, design for rigidity. Keys and couplings: Types of keys, splines, selection of square & flat keys, strength of sunk key, design of rigid and flexible couplings.

2. Pre-requisites:

Engineering Mechanics (MEL1101)
Strength of Materials (MEL1303)

3. Course Outcomes:

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

- Understand, identify and quantify failure modes for mechanical parts.
- Design a component subjected to static loads based on strength and stiffness criterion.
- Develop understanding of stress concentration and fatigue and apply the same.
- Design various joints, screwed connections, shafts, keys and couplings.
- Demonstrate knowledge on basic machine elements.
- Provide alternate design solutions based on design requirement.

4. Broad Course Outline:

- Introduction
- Design Against Static Load

- Design Against Fluctuating Loads
- Design of Riveted Joints
- Design of Threaded Joint
- Design of Welded Joints
- Keys and Couplings

5. Study Materials:

Text Books:

- V.B. Bhandari, Design of Machine Elements, McGraw-Hill Education.
- R.G. Budynas & J.K. Nisbett, Shigley's Mechanical Engineering Design, McGraw Hill Education.
- Faculty of Mechanical Engineering, PSG College of Technology, Design Data: Data Book of Engineers, Kalaikathir Achchagam, Coimbatore

Reference Books:

- H. Burr & J.B. Cheatham, Mechanical Analysis and Design, Prentice Hall.
- R.S. Khurmi & J.K. Gupta, A Textbook of Machine Design, S. Chand & Co.

MEL1505: Industrial Engineering and Management

1. Course Description:

Production, Planning and Control: Definition and importance; types of production -job, batch and mass; routing, scheduling, dispatching and follow up; Break even analysis; application of CPM and PERT techniques Analysis and control of project cost in CPM and PERT.
Work Study: Definition, advantages and procedure of work-study; Method Study: - Definition, objectives and procedure of method study. Symbols, flow process chart (man-machine-material), flow diagram, machine chart, two hand chart Critical examination. Developing a new method Principles of motion economy. Therblig symbols, SIMO chart, simple problems. Work Measurement -time study, definition, principle and method of time study Stop watch study - number of reading, calculation of basic time, rating techniques, normal time, allowances, standard time; Work Sampling - Definition, method, advantages and disadvantages of work sampling Applications.
Plant Location and Layout: Definition, factors affecting the site selection of plant Factor affecting plant layout Types of layout - process, product, combination, and fixed position layout, Techniques in making a layout-Flow diagram.
Material Handling: Principles of economic material handling, Hoisting equipment - forklift truck, Cranes- mobile motor cranes, overhead cranes, traveling bridges crane; Derrick crane; Whiler crane Conveying equipment - Package conveyors, gravity roller conveyors, screw conveyors, flight or scraper conveyors, bucket conveyors, bucket elevators, belt conveyors, pneumatic conveyors.
Quality Control: Introduction and definitions of quality, Evolution of Quality: Inspection, Quality Control Customer-Orientation: Internal & External Customer Concept, Life cycle approach to quality costs- Prevention; Appraisal and Failure costs. Seven QC tools (Histogram, Check sheets, Ishikawa diagrams, Pareto, Scatter diagrams, Control charts).**2.**

2. Course Outcomes (COs):

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

- Gain understanding of Material Handling in industries
- Understanding the application of Plant Location and Layout and Production, Planning and Control.
- Gain an understanding of Quality Control Techniques and its applications in engineering industries
- Calculate the queue length and waiting time for queuing models to make business decisions in operational research.

- Apply mathematical techniques to solve decision models using search techniques and dynamic programming methods.

3. Pre-requisite:

Engineering Mathematics (MAL 1101)
Social Science (HUL 1202)

4. Broad Course Outline:

- Introduction
- Performance rating
- Quality
- Site Selection
- Operation Research
- Inventory
- CPM and PERT

4. Study Materials:

Text Books

- S.N. Chary, Production And Operations Management, McGraw Hill
- Saxena, Production and Operations Management, McGraw Hill
- O.P. Khanna, Industrial engineering and management, Dhanpat Rai & Sons

Reference Books

- Chase, Operations and Supply Management (SIE), McGraw Hill

MEL1506: Sustainable Engineering

1. Course Description:

Introduction to sustainability: Roles of engineers in developing a sustainable society, principles and indicators of sustainability, metrics and assessment tools of sustainability, industrial activities, and other emerging challenges to sustainability. Sustainable development Goals: Natural resources and global issues, criteria for sustainable development, sustainable development goals (SDG), and it's relation with sustainable engineering. Applications of sustainability concepts to various engineering disciplines. Sustainable engineering practices: Green engineering, sustainable energy generation and utilization, sustainable waste management, green and sustainable buildings, design for the environment, sustainable manufacturing process and product design. Mass and energy balances in the design of sustainable systems. Environmental assessment tools for sustainability: Carbon footprint analysis, environmental codes, and regulations. Economic assessment tools for sustainability: Process life cycle, product life cycle assessment, cost-benefit analysis. Sustainable engineering in Government and society. Relation of engineering ethics to sustainability. Case studies and group project presentations on sustainability.

2. Pre-requisites:

Engineering Physics (PHL 1201)
Engineering Chemistry (CHL 1101)
Social Science (HUL 1202)

3. Course Outcomes:

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

- Understand the roles of engineers in sustainable engineering and sustainable development goals.
- Understand sustainability concerns and measures to social, economic and environmental issues.
- Apply sustainability concept in different engineering practices.
- Evaluate an engineering system through mass and energy balance.
- Evaluate an engineering system through life cycle analysis and cost-benefit analysis.
- Design and present a project on sustainable engineering system.

4. Broad Course Outline:

- Overview of sustainability concept
- Indicators of sustainability
- Metrics and assessment tools of sustainability
- Emerging challenges to sustainability
- Sustainable development goals
- Sustainable engineering practices
- Environmental assessment tools
- Economic assessment Tools
- Sustainable engineering in Government and society
- Case study and group presentation

5. Study Materials:

Text Books

- B.R. Bakshi, Sustainable Engineering: Principles and Practice, Cambridge University Press.
- C. Cameselle, K.R. Reddy, and J.A. Adams, Sustainable Engineering: Drivers, Metrics, Tools, and Applications, Wiley.
- D.A. Vallero, and C. Brasier, Sustainable Design: The Science of Sustainability and Green Engineering, Wiley-Blackwell.

Reference Books

- T.E. Graedel, and B.R. Allenby, Industrial Ecology and Sustainable Engineering, Prentice Hall.
- W. Wimmer, and J. Kauffman, Handbook of Sustainable Engineering, Springer.
- N. Chang, Systems Analysis for Sustainable Engineering: Theory and Applications, McGraw-Hill.

MEP1501: Heat Transfer Laboratory

List of Experiments:

- Determination of thermal conductivity of insulating powder at an average temperature
- Determination of thermal conductivity of metal rod (Brass, Copper, Aluminium)
- Study of heat transfer in natural convection
- Study of heat transfer in forced convection
- Demonstration of thermal conductivity of heat pipe
- Study of heat exchanger service unit
- Study of Stefan-Boltzmann apparatus

MEP1502: Manufacturing Laboratory-II

List of experiments:

- To manufacture jobs according to given drawing on the centre lathe.
- To perform V-thread cutting on a lathe forming right hand and left hand metric threads.
- To perform milling operation on the given workpiece according to the drawing provided.
- To manufacture jobs according to the given drawing on the shaper.
- To perform different machining operations on drilling machine.
- To perform surface grinding and cylindrical grinding operation on the given work piece.
- Measurement of lengths, heights, diameters of given specimen by vernier calipers, micrometers etc.
- Angle and taper measurements by bevel protractor, sine bars, etc.
- Measurement of flatness of a surface and alignment test of different machine tool.
- Thread measurement by two wire/ three wire method.

MEP1503: Dynamic of Machines Laboratory

List of Experiments:

- Experimental investigation of the Characteristics of Dead Weight Mechanical Governor.
- Experimental investigation of the Characteristics of Spring Controlled Governor.
- Determination of Critical Speed in Whirling of Shafts.
- Study of the Principles of Gyroscope and Verification of the Equation of Gyroscopic Couple.
- Study of the Concept of Statics & Dynamic Balancing of Rotating Masses in Single and Multi-Planes and Verification of Balancing Principles.
- Measurement of Slip in Flat Belt under Different Belt Tensions and Varying Load Conditions.
- Measurement of Slip in V Belt under Different Belt Tensions and Varying Load Conditions. Measurement of Creep in Flat Belt.
- Measurement of Creep in V Belt.

6th Semester:

Course Structure

SL. No	Course code	Subject	Teaching Scheme			Credits
Theory			**L**	**T**	**P**	
1.	MEL1601	Internal Combustion Engine	3	0	0	3
2.	MEL1602	Automation and Advanced Manufacturing	3	0	0	3
3.	MEL1603	Turbo Machinery	2	1	0	3
4.	MALXXXX	Operation Research	3	0	0	3
5.	MEL1604	Machine Design– II	2	1	0	3
Practical						
6.	MEP1601	IC Engine Laboratory	0	0	2	1
7.	MEP1602	Industrial Training Viva	0	0	2	1
8.	MEP 1603	Thermal Engineering Laboratory	0	0	2	1
9.	MEP 1604	Advance Manufacturing Laboratory	0	0	2	1
10.	MEP 1605	Mini Project	0	0	4	2
					Total	**21**

MEL1601: Internal Combustion Engine

1. Course Description:

Concept of Engine Classifications, Review of Air Standard Cycles, Actual Cycle Analysis, Two and Four Stroke SI and CI Engines, Valve Timing Diagram for Two and Four Stroke Engine At Low and High Speed. Important Qualities of SI and CI Engine Fuels, Rating of SI Engine and CI Engine Fuels, Dopes, Additives, Concept of Gaseous Fuels, Alternative Fuels and Bio Diesel, Calculation of Performance Parameters, Emission Control Devices and Norms Like Euro and Bharat Norms. Combustion Details of SI Engine, Stages of Combustion, Flame Speed, Ignition Delay, Abnormal Combustion and Its Control, Types of Combustion Chamber, Carburetor, Fuel Injection System and Their Components, MPFI. Combustion Details of CI Engines, Stages of Combustion, Ignition Delay, Knock, Abnormal Combustion, Types of Combustion Chamber, Fuel Injection System of CI Engines and Their Components, Injection Timings. Basic Concepts and Their Applications Types of Supercharging Methods, Supercharger and Turbocharger, Calculation of Supercharger. Basic Concepts of Advanced Engines.

2. Course Outcomes (COs):

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

- Explain the various types of chassis, frames, and functions of IC engine parts.
- Describe the engine auxiliary system used in SI and CI engine.
- Distinguish between manual transmission systems with automatic transmission systems.
- Know about Gas Turbine and Jet Propulsion system
- Justify the importance of alternative fuels.

3. Pre-requisite:

Basic Thermodynamics (MEL 1304)
Applied Thermodynamics (MEL 1403)

4. Broad Course Outline:

- Introduction
- SI Engines
- CI Engine
- Gas Turbine and Jet Propulsion

4. Study Materials

Text Books:

- Ganeshan, I. C. Engines: TM
- Heywood: Internal Combustion Engine Fundamental: TMH

Reference Books

- W. W. Pulkrabek: Engineering Fundamentals of I. C. Engines
- M. L. Sharma & R.P. Sharma: A course in I. C. Engines

MEL1602: Automation and Advanced Manufacturing

1. Course Description:

Introduction to computer-aided design (CAD), computer-aided manufacturing (CAM), and computer-aided engineering (CAE) systems, product cycle. Computer graphics, transformation matrix, principle of geometric modeling (wireframe, surface and solid modeling). Numerical control (NC), computer numerical control (CNC), direct numerical control (DNC), comparison between conventional and CNC systems, classification of CNC system, NC coordinate system, positional control, system devices, interpolators, adaptive control system, concepts for manual and computer assisted part programming. Introduction to part families, parts classification, and coding systems. Group technology. Computer-aided process planning (CAPP). Flexible manufacturing system (FMS). Industrial robots, end effectors, and grippers of robots. Introduction to components of computer integrated manufacturing (CIM).

Working principles & applications of laser beam machining (LBM), electron beam machining (EBM), electrochemical machining (ECM), electric discharge machining (EDM), abrasive jet Machining (AJM), etc. Advanced welding processes: laser beam welding (LBW), electron beam welding (EBW), Electromagnetic welding, etc.

2. Pre-requisite:

Basics of Manufacturing Process (MEL1405)
Machining Technology and Metrology (MEL1502)

3. Course Outcome:

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

- Analyze and assess the importance of automation and industrial automated systems
- Identify and analyze functions and functioning of CNC machines
- Recognize the need for non-traditional machining processes and understand the working of high-energy beam machining
- Illustrate underlying mechanisms in non-traditional machining processes along with their applications

4. Broad Course Outline:

- Computer-Aided Design

- Numerical Control of Machine Tools
- NC Part Programming
- Group Technology (GT)
- Process Planning
- FMS and CIM
- Advanced Machining
- Advanced Welding

5. **Study Materials:**

Text Books:

- E. Zimmer, and M. Groover, CAD/CAM Computer Aided Design and Manufacturing, Pearson Education.
- A. Ghosh, and A. K. Mallik, Manufacturing Science, East-West Press Pvt. Ltd.

Reference Books:

- M. Groover, Automation, Production Systems and Computer Integrated Manufacturing, Pearson Education.
- Yoram Koren, Computer control of manufacturing system, Mc Graw Hill.
- P. Radhakrishnan, S. Subramanyan, and V. Raju, CAD/CAM/CIM, New Age.
- M. Groover, Industrial Robotics, McGraw-Hill Education.
- Groover, M. P., "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems", Wiley Publication.
- P. K. Mishra, Nonconventional Machining, Narosa Publishing House.

MEL1603: Turbo Machinery

1. Course Description:

Introduction: Impulse-momentum principle, definition of a turbo-machine, fundamental theory of turbo-machines, and classification of turbo machines. Hydraulic Turbines: Introduction, classifications of hydraulic turbines, concepts of heads of turbines, concept and definitions of efficiencies of turbines. Impulse turbines- main components of Pelton turbines, design of components of Pelton turbines, force, power and efficiency of Pelton turbine. Reaction Turbines- Main components of modern Francis turbine, design of components of Francis turbine, torque, power and efficiency of Francis turbine, components and design of propeller and Kaplan turbines. Draft tube, function and efficiency of draft tube, types of draft tube, governing of hydraulic turbines, specific speed, performance characteristic curves of turbines, model selection and performance of turbines, cavitation of turbines. Centrifugal Pumps: introduction, main components of centrifugal pumps, definitions of head and efficiency of a centrifugal pump, working principle, priming of centrifugal pump, multistage centrifugal pumps, specific speed, performance characteristic curves of pumps, selection and performance of a centrifugal pump, cavitation in pump, operational difficulties in centrifugal pumps, axial flow pumps. Steam Turbines: introduction, working principle of steam turbine, classification of steam turbine, simple impulse turbine, compounding of steam turbine, pressure compounded impulse turbine, velocity compounded impulse turbine, pressure-velocity compounded impulse turbine, flow through impulse turbine blades, velocity triangle, work done, power and efficiencies, blade sections, flow through impulse reaction turbine blades, velocity triangles, work done, efficiencies, degree of reaction, Parson's Turbine, blade sections, governing of steam turbines, losses of steam turbines, state point locus, reheat factor, turbine efficiency parameters. Compressors, Fan and Blower: Introduction, classification of compressors, basic components, principle of working, velocity triangles, enthalpy-entropy diagram, performance coefficients, effect of impeller blade shape on performance, vanned and vaneless diffuser, efficiency, degree of reaction, issues and challenges- stalling, surging, choking, slip, centrifugal fan, impeller, performance and point of operation, blade profiles, performance of blowers.

2. Pre-requisite:

Fluid Mechanics (MEL 1302)
Fluid Machinery (MEL 1402)

3. Course Outcomes (COs):

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

- Recognize different turbo machinery and their applications.

- Design different turbo machineries.
- Analyse different turbo machineries.
- Synthesize the operations of turbo machineries.

4. Broad course outline:

- Introduction
- Hydraulic Turbines
- Centrifugal Pumps
- Steam Turbine
- Compressor, Fan and Blower

5. Study Materials:

Text Books:

- Ganesan. Gas Turbine. McGraw-Hill Education, 3/e.
- Jagdish Lal. Hydraulic Machines. Metropolitan Publication.
- R. Yadav. Steam & Gas Turbine and Power Plant Engineering. Central Pub. House.

Reference Books:

- S. L. Dixon. Fluid Mechanics and Thermodynamics of Turbomachinery. Butterworth-Heinmann.
- Earl Logan Jr. Turbomachinery. Marcel Dekker Inc.
- R. K. Bansal. A Text Book of Fluid Mechanics and Hydraulic Machines. Laxmi Pub.

MAL XXXX: Operational Research

1. Course Description:

Introduction: Basics definition, scope, objectives, phases, models, and limitations of Operations Research; Linear Programming Problem: Formulation of LPP, Graphical solution of LPP; Simplex Method, Artificial variables, Big-M method, Two-phase method, degeneracy, and unbound solutions; Revised Simplex Method: Duality of Linear Programming Problem, Dual simplex; Inventory related costs: EOO model, EPO model, Inventory models allowing shortages, Inventory models allowing price discounts; Transportation Problem: Formulation, solution, unbalanced Transportation problem; Finding basic feasible solutions: Northwest corner rule, least cost method and Vogel's approximation method; Optimality test: the stepping stone method and MODI method; Assignment model: Formulation, Hungarian method for optimal solution, Solving unbalanced problem, Traveling salesman problem and assignment problem; Integer programming: Modelling with integer variables, methodologies, branch-and-bound and cutting-plane techniques.

2. Course Outcomes (COs):

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

- Identify and formulate LP problems using various methods for maximization and minimization problems.
- Apply mathematical techniques in different application areas of operations research, like transportation and network models.
- Formulate mathematical models for quantitative analysis of Inventory control practice in the industry.

3. Pre-requisite:

Engineering Mathematics- I (MAL 1101)

Engineering Mathematics- II (MAL 1201)

4. Broad Course Outline:

- Introduction to linear programming
- Knowledge on transportation & assignment problems
- Idea of dynamic programming
- Idea of Queuing theory

- Idea of Inventory and product control

5. Study Materials:

Text Books

- Iyer, P.S., Operations Research, Tata McGraw Hills.
- Rao, S.S., Engineering Optimization, New Age International Limited.

Reference Books

- Taha, H.A., Operations Research, Pearson Education India.

MEL1604: Machine Design-II

1. Course Description:

Mechanical springs: Types of springs, spring materials, design of helical coil springs and leaf springs. Power Screws: Forms of threads, design of power screws with square and trapezoidal threads, self -locking screw, design of screw jack. Belt drives: Types of belt drives, materials for belt and pulley, design of belt and pulley. Clutch: Positive and friction clutch, types of friction clutch, design of plate friction or disc clutch, cone clutch, centrifugal clutch. Brakes: Types of brakes, material, design of block brake, band brake, disc brakes. Gear drives: Types of gears, gear terminology, gear profiles, Interference in involute gears, backlash, lubrication, gear material, gear tooth failure, design based on strength, dynamic load and wear. Bearing: Types of bearings, selection of bearing, theory of lubrication, hydrostatic and hydrodynamic bearings, rolling element bearings, life of bearings, equivalent bearing load, load- life relations.

2. Pre-requisites:

Engineering Mechanics (MEL1101)
Strength of Materials (MEL1303)

3. Course Outcomes:

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

- Apply the design principles for the design of mechanical systems involving springs, belts, pulleys and wire ropes.
- Understand the design principles of brakes and clutches.
- Design different types of gears and simple gear boxes for relevant applications.
- Apply design concepts of hydrodynamic bearings for different applications.
- Acquaintance with design of the components as per the industrial standard.

4. Broad Course Outline:

- Springs
- Power Screw
- Belt Drive
- Clutch
- Brakes
- Gear drives

- Bearing

5. Study Materials:

Text Books:

- V.B. Bhandari, Design of Machine Elements, McGraw-Hill Education.
- R.G. Budynas & J.K. Nisbett, Shigley's Mechanical Engineering Design, McGraw Hill Education.
- Faculty of Mechanical Engineering, PSG College of Technology, Design Data: Data Book of Engineers, Kalaikathir Achchagam, Coimbatore.

Reference Books:

- H. Burr & J.B. Cheatham, Mechanical Analysis and Design, Prentice Hall.
- R.S. Khurmi & J.K. Gupta, A Textbook of Machine Design, S. Chand & Co.
- M. Maitra, Handbook of Gear Design, Tata McGraw Hill.

MEP1601: IC Engine Laboratory

List of Experiment

- Study of Cetane No. Diesel and Biodiesel
- Study of Octane No. Petrol and Ethanol
- Study of Flash Point and Fire Point Diesel and Biodiesel.
- Performance Study of Four Stroke SI Engine
- Performance Study of Four Stroke CI Engine
- Performance Study of Two Stroke SI Engine
- Performance Study of Four Stroke CI Engine using Biofuel.

MEP1602: Industrial Training Viva

The student will submit one training report, certificate of training and power point presentation to the Department before end semester examination.

MEP 1603: Thermal Engineering Laboratory

List of Experiment

- Performance Study of Refrigeration System
- Performance Study of Air-conditioning Unit
- Study of Shock Wave in Supersonic Tunnel
- Performance Study of the Drying Unit
- Determination of Calorific Value of Fuels using Bomb Calorimeter

MEP 1604: Advanced Manufacturing Laboratory

List of experiments:

- To study the fundamentals of CNC machines.
- To study the different codes used in CNC machines.
- To perform turning operation on the CNC Lathe machine.
- To produce a given profile using a CNC Milling machine.
- To study and perform machining operations on Electric Discharge Machine.
- To study and analyze the working principles of 3D printing.

MEP 1605: Mini Project

The student will perform a mini-project under the supervision of faculty members in the department.

7th Semester

Course Structure

SL. No	Course code	Subject	Teaching Scheme			Credits
Theory			**L**	**T**	**P**	
1.	MEL17XX	Elective – I	3	0	0	3
2.	MEL17XX	Open Elective	3	0	0	3
Practical						
3.	**MEP1701**	**Project-I**	**0**	**0**	**10**	**5**
		Total				**11**

List of Electives I for 7th Semester

SL. No	Course code	Subject	Teaching Scheme			Credits
			L	**T**	**P**	
1.	MEL1701	Power Plant Technology	3	0	0	3
2.	MEL1702	Mechanical Measurements	3	0	0	3
3.	MEL1703	Mechanical Vibration	3	0	0	3
4.	MEL1704	Computational Fluid Dynamics	3	0	0	3
5.	MEL1705	Combustion	3	0	0	3
6.	MEL1706	Automobile Engineering	3	0	0	3

List of Open Electives for 7th Semester

SL. No	Course code	Subject	Teaching Scheme			Credits
			L	**T**	**P**	
1.	MEL1707	Renewable Energy Systems	3	0	0	3
2.	MEL1708	Robotics & FMS	3	0	0	3
3.	MEL1709	Finite Element Method	3	0	0	3
4.	MEL1710	Neural Networks	3	0	0	3

MEL1701: Power Plant Technology

1. Course Description:

Introduction to different power plants. National and global energy scenario and energy mix. Steam power plant: introduction, Rankine cycle, Carnot cycle, reheating of steam, regeneration, steam power plant appraisal, deaeration, typical layout of steam power plant, efficiencies in steam power plant, different types of fuel used for steam generation, draught system; classification of boilers, boiler accessories, classification of steam turbines and their working; co-generation plant for power and process heat, combined cycle plant for power generation. Diesel and gas turbine power plant: introduction, Otto, Diesel, Dual & Brayton cycles, classification of different gas turbine power plants, analysis of closed cycle and open cycle constant pressure gas turbine plant, components of gas turbine plants. Hydroelectric power plant: introduction, classification of hydro-electric power plant, site selection, hydrographs, flow duration curves, elements of hydro-electric power plant, advantages of hydroelectric power plant, classification of hydraulic turbines and its selection. Nuclear power plant: introduction to nuclear engineering, types of nuclear reactors, pressurized water reactor, boiling water reactor, CANDU reactor, gas-cooled reactor, liquid metal fast breeder reactor, India`s nuclear power programme. Power from renewable energy: principle, construction and working of wind, tidal, solar photo voltaic (SPV), solar thermal, geothermal, biogas and fuel cell power systems. Power plant economics and environmental Issues: power tariff types, load distribution parameters, load curve, comparison of site selection criteria, relative merits & demerits, capital & operating cost of different power plants, pollution control technologies.

2. Pre-requisites:

- Applied Thermodynamics (MEL1403)
- Turbomachinery (MEL1603)

3. Course Outcomes (COs):

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

- Comprehend different types of power plants, national and global energy scenario and energy mix.
- Calculate the performance of steam turbine power plants.
- Evaluate the working and performances of hydroelectric and nuclear power plant.
- Evaluate the working and performances of diesel & gas turbine power plant.
- Understand power from different renewable energy sources.
- Select the site for different power plant.
- Calculate power plant economics.
- Comprehend environmental concerns for different types of power plants.

4. Broad Course Outline:

- Introduction to different types of power plants
- Steam power plant
- Diesel and gas turbine power plant
- Hydro-electric power plant
- Nuclear power plant
- Energy from renewable energy
- Power plant economics

5. Study Materials:

Text Books:

- R.K. Rajput, A Textbook of Power Plant Engineering, Laxmi Publications.
- P.K. Nag, Power Plant Engineering, Tata McGraw Hill.
- D.K. Mandal, S. Chakrabarti, A.K. Das, and P.K. Das, Power Plant Engineering, Wiley.

Reference Books:

- Dom Kundwar, and A. Dom Kundwar, Power Plant Engineering, Dhanpat Rai & Sons.
- R.K. Yadav, Steam & Gas Turbines & Power Plant Engineering: Central Publishing House.
- P.C. Sharma, A Textbook of Power Plant Engineering, S.K. Kataria & Sons.

MEL1702: Mechanical Measurements

1. Course Description:

Introduction to measurement systems: errors in measurement, hysteresis and linearity in measurement systems, resolution of measuring instruments, threshold, drift, zero stability, loading effects, system response, functional elements of measurement systems. Transducers: introduction and functions of transducers, transfer efficiency, classification of transducers, quality attributes for transducers, intermediate modifying devices. Force measurement: introduction to force measurement methods, force measurement in elastic members, load cells, cantilever beams, proving rings, differential transformers. Torque measurement: torque measurement techniques, torsion-bar dynamometer, servo-controlled dynamometer, absorption dynamometer, torque sensors. Strain measurement: mechanical and electrical strain gauges, strain gauge materials, gauge factor, theory of strain gauges, methods of strain measurement, temperature compensation in strain gauges. Temperature measurement: methods of measuring temperature, thermocouples and it's classification and application, resistance temperature detectors, thermistors; thermometers, pyrometry. Pressure measurement: pressure measurement scales, static pressure measurement, classification of pressure measuring devices, manometers for pressure measurement, pressure transducers, dead-weight pressure gauge, gauges for vacuum pressure, high pressure measuring instruments. Flow measurement: flow velocity measurement devices; pitot static tube and impact probes, velocity measurement based on thermal effects, velocimetry; measurement devices of volumetric flow rate.

2. Pre-requisites:

Fluid Mechanics (MEL1302)
Basic Thermodynamics (MEL1304)
Material Science (MEL1301)

3. Course Outcomes (COs):

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

- Understand the significance of measurement systems, transducers, intermediate modifying and terminating devices.
- Identify the use of different force and strain measuring instruments.
- Interpret different torque measurement methods and instruments.
- Comprehend the fundamentals and applications` of different types of temperature measurement devices.
- Select pressure measurement devices based on the specific application.
- Understand the application of flow measurement devices.

4. Broad Course Outline:

- Introduction to mechanical measurements
- Transducers
- Force measurement
- Torque measurement
- Strain measurement
- Temperature measurement
- Pressure measurement
- Flow measurement

5. Study Materials:

Text Books:

- N.V. Raghavendra, and L. Krishnamurthy, Engineering Metrology and Measurements. Oxford University Press.
- T. Beckwith, and R. Marangoni, Mechanical Measurements. Pearson.
- S.P. Venkateshan, Mechanical Measurements. Springer.

Reference Books:

- D.S. Kumar, Mechanical Measurements and Control. Metropolitan Book Co. Pvt. Ltd..
- R.K. Rajput, Mechanical Measurements and Instrumentation. S.K. Kataria & Sons.
- R.K. Jain, Mechanical and Industrial Measurements. Khanna Publishers.

MEL1703: Mechanical Vibration

1. Course Description:

Concept of Simple Harmonic Motion: Natural frequencies and Resonance, D'Alembert's Principle, Lagrange's Equation. Free and forced vibrations: principle and normal modes, Vibration absorbers; Free and Forced damped vibration: Types of damping, Logarithmic decrement, Equivalent viscous damping, Critical Speed and Effect of Damping, Support excitation, Vibration Isolation and Transmissibility. Vibration Measurements: Various methods of analysis of multi-degree freedom systems, Influence coefficients, coupling of modes, Numerical methods, Dunkerley's equation, Holzer's method, Vibration measuring instruments. Torsional Vibrations. Transverse Vibration of Strings. Longitudinal Vibration of Bars. Lateral Vibrations of Beam. Introduction to Non-Linear Vibrations. Introduction to Condition Monitoring of Machinery, FFT.

2. Pre-requisite:

Kinematics of Machine (MEL 1401)

3. Course Outcomes (COs):

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

- Understand the fundamentals of vibration
- Know about Newton's law, Lagrange's equation
- Know about damping and vibration-measuring instruments
- Understand multi degrees of freedom
- Know about longitudinal and lateral vibration

4. Broad Course Outline:

- Fundamentals of Vibration
- Free and Forced Vibrations of Single Degree of Freedom System
- Two Degrees of Freedom Systems
- Multi Degree of Freedom Systems
- Vibration of Continuous Systems

5. Study Materials:

Text Books

- T. Gowda, D V Girish & T Jagdeesha: Mechanical Vibrations: McGraw-Hill Education.
- Kelley, Mechanical Vibrations- Theory and Applications, Cenage Publisher
- Francis, Morse and Hinkle, Mechanical Vibration- Theory and Application, CBS Publishers.

Reference Books

- W. T. Thomson, Theory of Vibration with Application, Pearson Education

- G. K. Grover, Mechanical Vibration, New Chand & Brothers.
- K. Pujaria, Vibration and noise for engineers, Dhanpat Rai & Sons
- J. S. Rao & G. K.Guptam, Introductory Courses On Theory And Practice of Mechanical Vibration, Willey Eastern Publishing Ltd.

MEL 1704: Computational Fluid Dynamics

1. Course Description:

Introduction to the governing equations of fluid dynamics: general form of a conservation law, equation of mass conservation, conservation law of momentum, conservation equation of energy. The dynamic levels of approximation. Mathematical nature of PDEs and flow equations. Introduction to Finite Difference Method (FDM). Analysis and application of numerical schemes: consistency, stability, convergence, Fourier or von Neumann stability analysis; application of FDM to wave, Heat, Laplace and Burgers equations. Integration methods for systems of ODEs. Finite Volume Method (FVM) and conservative discretization. Numerical solution of the incompressible Navier-Stokes equations: explicit and implicit methods, pressure correction techniques like SIMPLE, SIMPLER and SIMPLEC. Introduction to compressible flows and Euler equations. Introduction to upwind schemes. Introduction to turbulence modeling: Reynolds averaged Navier-Stokes equations, RANS modeling, DNS and LES.

2. Pre-requisites:

Fluid Mechanics-I (MEL1302)
Fluid Mechanics-II (MEL1402)

3. Course Outcomes (COs):

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

- Understand conservation laws and apply in the flow governing equations
- Model laminar and turbulent flow using assumptions
- Perform discretization of diffusion problems using finite difference and finite volume methods.
- Model one dimensional convection– diffusion problems.
- Apply different turbulence models to solve Navier-stokes equations.
- Solve pressure corrections with SIMPLE, SIMPLER and SIMPLEC method
- Solve incompressible fluid flow and heat transfer problems
- Understand the application of computation fluid dynamics in compressible flow problems
- Model turbulent flow

4. Broad Course Outline:

- Introduction to CFD
- Spatial discretization
- Finite Difference Schemes
- Finite Volume Method
- Navier-Stokes equations

- Pressure correction techniques
- Compressible flows and Euler equations
- Turbulence modelling

5. Study Materials:

Text Books:

- J. C. Tannehill, D. A. Anderson, and R. H. Pletcher, Computational Fluid Mechanics and Heat Transfer, CRC Press.
- J. D. Anderson Jr., Computational Fluid Dynamics, McGraw-Hill International Edition.
- S.V. Patankar, Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corporation.
- H. K. Versteeg and W. Malalasekera, An introduction to computational fluid dynamics: The finite volume method, Pearson Education.

Reference Books:

- J. H. Ferziger, and M. Peric, Computational Methods for Fluid Dynamics, Springer.
- T. J. Chung, Computational Fluid Dynamics, Cambridge University Press.
- C. A. J. Fletcher, Computational Techniques for Fluid Dynamics, Vol. 1 and 2, Springer.
- C. Hirsch, Numerical Computation of Internal and External Flows, Vol.1 and 2, John Wiley & Sons.

MEL1705: Combustion

1. Course Description:

Introduction to combustion, Applications of combustion, Types of Fuels and various modes of combustion, Scope of combustion. Thermodynamics properties, Laws of thermodynamics, Stoichiometry, Thermo chemistry, adiabatic temperature, chemical equilibrium. Basic Reaction Kinetics, Elementary reactions, Chain reactions, Multistep reactions, simplification of reaction mechanism, Global kinetics. Fundamental laws of transport phenomena, Conservations Equations, Transport in Turbulent Flow. One dimensional combustion wave, Laminar premixed flame, Burning velocity measurement methods, Effects of chemical and physical variables on Burning velocity, Flame extinction, Ignition, Flame stabilizations, Turbulent Premixed flame. Gaseous Jet diffusion flame, Liquid fuel combustion, Atomization, Spray Combustion, Solid fuel combustion. Atmosphere, Chemical Emission from combustion, Quantification of emission, Emission control methods.

2. Pre-requisite:

Basic Thermodynamics (MEL 1304)
Applied Thermodynamics (MEL 1403)

3. Course Outcomes (COs):

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

- Know about combustion
- Know about types of fuels and various modes of combustion
- Grasp knowledge in details about laws of thermodynamics
- Understand conservations equation
- Know about burning velocity measurement method
- Know about liquid fuel combustion, solid fuel combustion
- Understand chemical emission from combustion

4. Broad Course Outline:

- Introduction
- Review of basic thermodynamics
- Chemistry of Combustion
- Physics of Combustion
- Premixed Flame
- Diffusion Flame
- Combustion and Emission

5. Study Materials:

Text Books

- Turns, An Introduction to Combustion: Concepts and Applications, McGraw-Hill Education.
- Kuo K.K, Principle of Combustion, John Wiley and Sons.

Reference Books

- D. P. Mishra, Fundamentals of Combustion, Prentice Hall Publishers.

MEL1706: Automobile Engineering

1. Course Description:

Automobile Engineering introduces you to the concept of Automotive Vehicles, its Development, Layout and types of automotive vehicles- cars, buses, tractors, air cushion vehicles, and off the road vehicles, Various resistance to the motion of a vehicle, Power required for propulsion, Acceleration and hill climbing. Classification, S.I. and C.I. engines, combustion chamber types, engine balancing, multi-cylinder arrangements. Cylinder block, cylinder head, crankcase, oil pan, cylinder liners, piston, piston rings, connecting rods, crankshaft, valves, valve actuating mechanism, valve layout, materials used, valve and port timing diagrams. Simple carburetor, constant choke, constant vacuum carburetor, types of carburetor, mixture strength requirements, fuel pumps for petrol engines, petrol injections, diesel fuel pump and fuel injector for diesel engines. Battery ignition system, comparison between battery ignition and magnetic ignition system, ignition advance methods, electronic ignition. Necessity, coolant types, methods of cooling. Objectives, system of engine lubrication, crank case ventilation. Purpose, requirements, relative merits and demerits of different types of clutches. Purpose, sliding mesh gear box, constant mesh gear box, power flow diagrams, torque converter, automatic transmission - an overview. Steering mechanisms, steering linkages, steering gears - for rigid front axle and independent front wheel suspension. Types of brakes, numerical problems relating to brake torque, minimum stopping distance with front wheel braking, rear wheel braking, wheel braking and heat dissipation.

2. Pre-requisite:

Internal Combustion Engine (MEL 1601)
Machine Design I (1504)
Machine Design II (MEL 1604)

3. Course Outcomes (COs):

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

- Explain fuel injection systems in SI engines, types of combustion chambers and combustion process.
- Explain different types of the fuel injection systems and combustion chambers of CI engine.
- Explain the mechanism of pollution formation and the evolution of emission norms.
- Describe the properties of various alternative fuels, engine modification required and emission characteristics of alternative fuels.
- Discuss various ignition methods used in I.C engine and electronic engine management system.

4. Broad Course Outline:

- Introduction
- Automotive engine
- Automobile engine parts
- Fuel supply system
- Ignition system
- Cooling system
- Lubrication system
- Clutches
- Transmission System
- Steering System
- Brakes

5. Study Materials:

Text Books

- Srinivasan, Automotive Mechanics, McGraw-Hill.
- Crouse, Automotive Mechanics, Tata McGraw Hill.

Reference Books

- Kirpal Singh, Automobile Engineering Vols - I & II, Standard Publishers Distributers.

MEL 1707: Renewable Energy Systems

1. Course Description:

Introduction to the concept of various renewable energy resources and their national and global energy mix and energy potential. Solar Energy: solar radiation, measurement of solar radiation, types of solar collectors and working principles, collector efficiency, storage of solar energy, application of solar energy, solar PV systems. Wind Energy: principles of wind energy conversion, wind turbine aerodynamics, wind power calculations, various types of wind machines and efficiencies. Bio-mass energy: bio-mass conversion technologies, different types of biogas plants, thermal gasification of biomass. Geothermal Energy: introduction to geothermal energy, classification of geothermal energy and their working principles. Tidal Energy: introduction to tidal energy, classification of tidal energy and their working principles. Hydrogen Energy: production and storage of hydrogen energy, application, limitations and recent developments.

2. Pre-requisites:

Fluid Mechanics- II (MEL 1402)
Heat transfer (MEL1501)

3. Course Outcome:

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

- Know the different sources of renewable energy.
- State the recent developments in renewable energy generation.
- Explain the functioning of solar collectors and solar PV systems.
- Analyse and identify suitable wind energy generators.
- Explain the energy generation methods from biomass.
- State the working principles of geothermal energy.
- Identify different types of tidal energy.
- Explain the functioning and limitations of hydrogen energy.

4. Broad Course Outline:

- Introduction to renewable energy
- Solar energy
- Wind energy
- Energy from biomass
- Geothermal energy
- Tidal Energy
- Hydrogen energy

5. Study Materials:

Text Books:

- M. Kanoglu, Y.A. Cengel, and J.M. Cimbala, Fundamentals and Applications of Renewable Energy, McGraw Hill.
- D.P. Kothari, K.C. Singal, and R. Ranjan, Renewable Energy Sources and Emerging Technologies, PHI Learning.

Reference Books:

- S.P. Sukhatme, and J.K. Nayak, Solar Energy: McGarw-Hill.
- J.F. Manwell, J.G. McGowan, A.L. Rogers, Wind Energy Explained: Theory, Design and Application, Wiley.
- H. Garg, J. Prakash, Solar Energy: Fundamentals and Applications: McGraw-Hill.
- J. Cheng, Biomass to Renewable Energy Processes, CRC Press.

MEL1708: Robotics & FMS (Flexible Manufacturing System)

1. Course Description:

Introduction: Persisted inefficiency & desired system, System configuration, Concept of flexibility. Flexible automation: Productivity, Purpose & motives of robotization. Robot & robotics: Basic elements of robot, Robot classification, Physical configuration, Robotic motion, Resolution, Accuracy & repeatability, Functional parameters. Robotic System: End effectors and grippers, Kinematics & dynamics of Manipulators, Robot capabilities; Robot application: Process wise & Industry wise, Selection & performance criteria, Robotic workstation design, Robot modularity planning of robotized projects & economic justification; FMS: Concept, objectives & its benefits, FMS Configuration, Data Files & Report, Selection of Different System Components.

2. Pre-requisite:

Engineering Mechanics (MEL 1101)

3. Course Outcomes (COs):

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

- Summarize the basic concepts of industrial robotics and key components of robotics technologies.
- Summarize the robot drive systems, grippers, and various end effectors.
- Describe the various sensors and image processing & data reduction method for the control of robots.
- Analyze the various kinematics of robots and prepare the robot program
- Explain the implementations of robots in industries and analyzing robot economics.

4. Broad Course Outline:

- Introduction
- Concept of flexibility
- Basic elements of Robot
- Classification
- Configuration
- Selection and Performance criteria
- Objectives and benefits of FMS

5. Study Materials:

Text Books

- Surender Kumar: Industrial Robots and Computer Integrated Manufacturing: Oxford & IBH Publishing Co. Pvt. Ltd.

- M P Groover: Automation, Production System & Computer Integrated Manufacturing: Pearson Education.

Reference Books

- T. Mason Matthew: Mechanics of Robotic Manipulation: MIT Press.
- Rachid Manseur: Robot Modeling and Kinematics: Firewall Media, New Delhi.

MEL 1709: Finite Element Method

1. 1. Course Description:

Introduction: Historical background, basic concept of the finite element method, comparison with finite difference method. Variational methods: Calculus of variation, the Rayleigh-Ritz and Galerkin methods. Finite element analysis of 1-D problems: Formulation by different approaches (direct, potential energy and Galerkin). Derivation of elemental equations and their assembly, solution and its post processing. Applications in heat transfer, fluid mechanics and solid mechanics. Bending of beams, analysis of truss and frame. Finite element analysis of 2-D problems: Finite element modelling of single variable problems, triangular and rectangular elements. Applications in heat transfer, fluid mechanics and solid mechanics. Numerical considerations: numerical integration, error analysis, mesh refinement. Plane stress and plane strain problems, bending of plates. Eigen value and time dependent problems. Discussion about preprocessors, postprocessors and finite element packages.

2. Pre-requisites:

Engineering Mathematics (MAL1101, MAL1202)
Engineering Mechanics (MEL1101)

3. Course Outcome:

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

- Explain the basics of Finite element method including its advantages.
- Apply finite element methods to real world problems and obtain solutions.
- Explain how the finite element method expands beyond the structural domain, for problems involving dynamics, heat transfer, and fluid flow.
- Interpret results obtained from FEA software solutions, not only in terms of conclusions but also awareness of limitations.
- Develop some experience with a commercial FEM code and some practical modeling exercises.

4. Broad Course Outline:

- Introduction to FEM.
- Variational methods.
- Finite element analysis of 1-D problems and applications.
- Finite element analysis of 2-D problems and applications.
- Numerical considerations in FEM.
- Introduction to finite element software packages.

5. Study Materials:

Text Books:

- J.N. Reddy, An Introduction to the Finite Element Method, McGraw Hill.
- D.V. Hutton, Fundamentals of Finite Element Analysis, McGraw Hill Education Pvt. Ltd.
- R.D. Cook, D. S. Malkus and M. E. Plesha, Concepts and Applications of Finite Element Analysis, John Wiley.

Reference Books:

- O.C. Zienkiewicz, R.L. Taylor and J.Z. Zhu, The Finite Element Method: Its Basis and Fundamentals, Butterworth-Heinemann.
- K.J. Bathe and E.L. Wilson, Numerical Methods in Finite Element Analysis, Prentice Hall.

MEL 1710: Neural Networks

1. Course Description:

Fundamentals of Neural Networks: What is Neural Network, Model of Artificial Neuron, Learning rules and various activation functions. Neural Network Architecture: Single layer Feed-forward networks. Multilayer Feed-forward networks. Recurrent Networks. Back propagation Networks: Back Propagation networks, Architecture of Back-propagation(BP) Networks, Back-propagation Learning, Variation of Standard Back propagation algorithms. Associative Memory: Autocorrelators, Hetero-correlators, Wang et al. Multiple Training Encoding Strategy, Exponential BAM, Associative Memory for Real coded pattern pairs, Applications. Adaptive Resonance Theory: Cluster Structure, Vector Quantization, Classical ART Network, Simplified ART Architecture, ART1 and ART Architecture and algorithms, Applications, Sensitivities of ordering of data.

2. Pre-requisite:

Engineering Mathematics- I (MAL 1101)
Engineering Mathematics- II (MAL 1201)

3. Course Outcomes (COs):

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

- Obtain the fundamentals and types of neural networks. The student will have a broad knowledge in developing the different algorithms for neural networks.
- Analyze neural controllers

4. Broad Course Outline:

- Introduction to Neural Networks
- Knowledge on Back propagation Networks
- Idea of Associative Memory Networks
- Idea of Adaptive Resonance Theory

5. Study Materials:

Text Books

- C. M. Bishop, Neural Networks for Pattern Recognition, Oxford University Press.
- S. Rajasekaran & G.A.V. Pai, Neural Networks, Fuzzy Logic and Genetic Algorithms, PHI.

Reference Books

- J.S.R. Jang, C.T. Sun and E. Mizutani, Neuro-Fuzzy and Soft Computing, PHI.

MEP1701: Project-I

As per the project decided by the student and concerned supervisor.

यांत्रिक अभियांत्रिकी विभाग

Department of Mechanical Engineering

8th Semester
Course Structure

SL.No	Course code	Subject	Teaching Scheme			Credits
Theory			**L**	**T**	**P**	
1.	MEL18XX	Elective II	3	0	0	3
2.	MEL18XX	Open Elective	3	0	0	3
Practical						
3.	MEP1801	Project- II	0	0	12	6
4.	MEP 1802	Grand Viva	0	0	4	2
		Total				**14**

List of Electives-II for 8th Semester

SL.No	Course code	Subject	Teaching Scheme			Credits
			L	**T**	**P**	
1.	MEL1801	Introduction to Aerodynamics	3	0	0	3
2.	MEL1802	Experimental Stress Analysis	3	0	0	3
3.	MEL1803	Introduction to Composite Materials	3	0	0	3
3.	MEL1804	Welding and Additive Manufacturing	3	0	0	3
5.	MEL1805	Refrigeration and Air Conditioning	3	0	0	3
6.	MEL1806	Tribology	3	0	0	3

List of Open Electives for 8th Semester

SL.No	Course code	Subject	Teaching Scheme			Credits
			L	**T**	**P**	
1.	MEL1807	Product Design and Manufacturing	3	0	0	3
2.	MEL1808	Innovation and entrepreneurship	3	0	0	3
3.	MEL1809	Fuzzy Systems and Genetic Algorithms	3	0	0	3
4.	MEL1810	Project Management	3	0	0	3

MEL1801: Introduction to Aerodynamics

1. Course Description:

Aerodynamic forces and moments; Center of pressure and aerodynamic center. Kinematics of fluid motion. Fluid flow governing equations: continuity and momentum equations, energy conservation and energy equation. Inviscid incompressible flow: Euler's equation of motion, source and doublet flows, non-lifting flow over a circular cylinder, Kutta-Joukowski theorem. Incompressible flow over airfoils and finite wings: Kutta condition, Kelvin's circulation theorem, Biot-Savart law, Helmholtz vortex theorem, Prandtle's classical lifting line theory, thin aerofoil theory. Viscous flows; Laminar and turbulent boundary layers. Panel methods in aerodynamics. Unsteady incompressible potential flow: sudden acceleration of a flat plate, unsteady motion of two-dimensional thin airfoil. Supersonic flows over airfoils and wings. Hypersonic flows: real gas effects, Newtonian theory, lift and drag in hypersonic flows. Introduction to experimental aerodynamics: subsonic and supersonic wind tunnels, measurement techniques and error analysis.

2. Pre-requisites:

Fluid Mechanics I (MEL1302)
Fluid Mechanics II (MEL1402)

3. Course Outcomes (COs):

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

- Apply governing equations of fluid mechanics to calculate flow properties
- Calculate the aerodynamic lift, drag and moments on the aerodynamics bodies
- Understand the classical and numerical methods of aerodynamic flow analysis, such as thin aerofoil theory, vortex panel methods, and lifting-line theory
- Calculate flow patterns, pressure distribution and forces in irrotational flows, using superposition principles.
- Apply boundary layer theory on the aerodynamic bodies
- Simulate aerodynamic unsteady flows over flat plate and thin airfoil
- Comprehend the subsonic, supersonic and hypersonic flows
- Understand the experimental techniques in aerodynamics

4. Broad Course Outline:

- Aerodynamic forces and moments
- Flow governing equations
- Incompressible flows

- Classical and numerical methods of flow analysis
- Application of boundary layer theory
- Unsteady incompressible potential flow
- Numerical simulations
- Supersonic flows
- Hypersonic flows
- Introduction to Experimental Aerodynamics

5. Study Materials:

Text Books:

- J.D. Anderson, Jr, Fundamentals of Aerodynamics, McGraw Hill.
- J.J. Bertin, and R.M. Cummings, Aerodynamics for Engineers, Pearson Education.
- L. Houghton, and N.B. Carruthers, Aerodynamics for Engineering Students, Butterworth-Heinemann.

Reference Books:

- M. Kuethe, and C.Y. Chow, Foundations of Aerodynamics: Bases of Aerodynamic Design, John Wiley & Sons.
- L.J. Clancy, Aerodynamics, Shroff.
- J. Katz, and A. Plotkin, Low-speed Aerodynamics: From Wing Theory to Panel Methods, McGraw-Hill.

MEL1802: Experimental Stress Analysis

1. Course Description:

Introduction: Strain rosette, Stress gauges, Over-deterministic methods for strain analysis, residual stress determination. Application of strain gauges for measurement of load, temperature, pressure, vibration, stress, and strain, etc. Basic of Optics: Optical instrumentation. Moiré Fringe technique: Theory and experimental procedures. Fractional fringe measurement: Tardy's Method, Babinet Soleil Method. Polariscope: Plane polariscope, Circular polariscope. Photo elastic photography: Photo elastic materials, casting methods, calibration. Determination of the direction of Principal stresses at a given point: Determination of exact fringe order N and the principal stress Separation methods, Electrical analogy method, Oblique incidence method, Shear difference method. Bi-fringing coating: stress-optic and strain-optic relation, sensitivity and coating materials, fringe order determination. Brittle coating technique.

2. Pre-requisite:

Strength of Material (MEL 1303)

Advanced Solid Mechanics (1404)

3. Course Outcomes:

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

- Know methods for stress and strain analysis
- Gain knowledge about the application of strain gauge
- Know about different measuring technique
- Understand Coating techniques and Holograph

3. Broad Course Outline:

- Strain Analysis Methods
- Optical Methods of Stress Analysis
- Theory of Photoelasticity
- Optical methods for Determining Fracture Parameters
- Coating Techniques and holography

4. Study Materials:

Text Books

- Budynas: Advance Strength & Applied Stress Analysis: McGraw-Hill.
- F. K Garas, J.L. Clarke and GST Armer, Structural Assessment, Butterworths, London.

- Sadhu Singh, Experimental Stress Analysis, Khanna Publishers, New Delhi.

Reference books:

- Dove and Adams, Experimental Stress Analysis and Motion Measurement, Prentice Hall of India.

MEL1803: Introduction to Composite Materials

1. Course Description:

Introduction: Definition, Classification, Types of matrices, Material and reinforcements, characteristics & selection, Fiber Composites, Laminated Composites, Particulate Composites, Prepegs, and Sandwich Construction. Hooke's Law for Different Types of Materials: Elastic Constants, Derivation of nine independent constants for orthotropic material. Two Dimensional Relationship of Compliance and Stiffness Matrix. Hooke's Law for Two Dimensional Angle Lamina. Engineering Constants: Numerical Problems. Invariant Properties. Stress-Strain Relations for Lamina of Arbitrary Orientation: Introduction, Evaluation of the Four Elastic Moduli, Rule of Mixture, Numerical Problems. Maximum Stress Theory, Maximum Strain Theory, TSA-Hill Theory, Tsai, Wu Tensor Theory, Numerical Problems, Code, Kirchoff Hypothesis, CL T, A, B, and D Matrices (Detailed Derivation). Special Cases of Laminates, Numerical Problems. Lay Up and Curing – Open and Closed Mould Processing, Hand Lay, Up Techniques, Bag Moulding and Filament Winding. Pultrusion, Pulforming, Thermoforming, Injection Moulding, Cutting, Machining and Joining, Tooling. Applications: Aircrafts, Missiles, Space Hardware, Automobile, Marine, Recreational and Sports Equipment. Future Potential of Composites. Metal Matrix Composites: Types, Characteristics and Selection, Base Metals, Selection, Applications.

2. Pre-requisite:

Material Science (MEL 1301)
Advanced Solid Mechanics (MEL 1404)

3. Course Outcomes (COs):

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

- Know about composite materials
- Know about types of matrices, material and reinforcements
- Gain knowledge about Hooke's Law for different types of material
- Know about Kirchoff hypothesis
- Know about application developments of aircrafts, missiles, space hardware.

4. Broad Course Outline:

- Introduction to Composite Materials
- Macro Mechanics of A Lamina
- Micro Mechanical Analysis of A Lamina
- Biaxial Strength Theories

- Macro Mechanical Analysis of Laminate
- Manufacturing
- Application Developments

5. Study Materials:

Text Books

- Mein Schwart, Composite Materials Handbook, Mc Graw Hill.
- K. Kaw Autar, Mechanics of Composite Materials, CRC Press New York.
- Madhujit Mukhopadhyay, Mechanics of Composite Materials and Structures, University Press.
- M. Joness Rober, Mechanics of Composite Materials, Mc-Graw Hill.

Reference Books

- W Michael, Stress Analysis of Fiber Reinforced Composite Materials, Hyer MGH International.
- K. Chawla Krishan, Composite Material Science and Engineering, Springer.

MEL1804: Welding and Additive Manufacturing

1. Course Description:

Introduction: Classification of joining processes, Type of welds and weld joints, Welding symbols and codes. Arc welding processes: Laser welding, Electron beam welding, Resistance spot welding, Friction stir welding. Types of power sources, Current-voltage and arc power – arc length characteristics; Synergic and pulsed welding; Forces on molten droplet, Mode of metal transfer in arc welding; Cold metal transfer. Analysis of heat flow, Cooling rates; Models for welding heat sources, Analytical solution of temperature distribution; Chemical reactions in welding; Solidification in welding and solidification cracking; Phase transformation in welded structure; Weld microstructure; Heat treatment of weld joint; Types of welding defects, their cause and remedies; Distortion and residual stress and their measurement; Weld testing methods: destructive and non-destructive, Analysis of welded structure for fatigue loading. Additive manufacturing: Introduction, Classification, Principle, Welding technology based metal 3D printing; Solid state additive manufacturing, Additive vs. subtractive manufacturing.

2. Pre-requisite:

Manufacturing Science and Technology (MEL 1405)

3. Course Outcomes (COs):

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

- Know about the welding process, welding symbols and codes
- Know about welding physics and mechanics
- Understand welding defects, welding-induced residual stress and distortion
- Know about 3D printing and additive manufacturing

4. Broad Course Outline:

- Introduction to the welding process
- Welding physics and metallurgy
- Welding defects
- Residual stress and distortion in weld joints
- Weld Testing Methods
- 3D printing and additive manufacturing

5. Study Materials:

Text Books:

- A. O'Brien, Welding Handbook: Welding Processes, Part 1, Vol. 2, 9th Ed., American Welding Society.
- J. F. Lancaster, The Physics of welding, Pergamon.
- R. W. Messler, Principles of Welding, John Wiley and Sons.

Reference Books

- S. Kou, Welding Metallurgy, 2nd Ed., Wiley Interscience, 2003
- V. M. Radhakrishnan, Welding technology and design, New Age International Private Ltd., 2nd Ed., 2005
- R. S. Parmar, Welding Processes and Technology, Khanna Publishers, 3rd Ed., 2015

J. A. Goldak, Computational Welding Mechanics, Springer, 2005

MEL 1805: Refrigeration and Air Conditioning

1. Course Description:

Introduction: definition of refrigeration and air conditioning; second law interpretation and refrigeration. Reversed Carnot cycle and its limitations. Vapour Compression Refrigeration Systems: modifications in Reversed Carnot cycle, superheat horn and throttling loss for various refrigerants, standard vapour compression refrigeration cycle. Refrigerants: designation and trade name, physical, chemical & thermodynamic properties of principal refrigerants, ODP and GWP of refrigerants. Multi-pressure systems: multistage compression, multi-evaporator systems, cascade systems. Refrigeration system components: types of compressors, expansion devices, condensers & evaporators. Absorption system of refrigeration: simple vapour absorption system, maximum COP of a heat operated refrigerating machine, common refrigerant-absorbent systems, modifications to simple vapour absorption system, Electrolux refrigerator. Psychrometry: air properties and psychrometric chart, sensible heating / cooling, humidification / dehumidification and their combinations, by-pass factor, sensible heat ratio, comfort, psychrometric calculations for cooling, evaporative cooling. Summer and winter air-conditioning: simple summer air conditioning process, room sensible heat factor, coil sensible heat factor, ADP, winter air conditioning. Load calculations: internal heat gain, system heat gain, break-up of ventilation load and effective sensible heat factor, cooling or heating load estimation.

2. Pre-requisites:

Applied Thermodynamics (MEL1403)

3. Course Outcome:

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

- Understand the concepts of refrigeration and air conditioning systems using various refrigerants.
- Explain vapor compression refrigeration systems with different refrigerants and infer the effect of different input parameters on the system performance and solve related problems.
- Describe the operating principle of different components of vapour compression, vapor absorption refrigeration systems, aircraft refrigeration.
- Solve combined psychrometric process problem using analytical method and psychrometric chart.
- Design the air-conditioning process utilizing the inside and outside environment condition.

4. Broad Course Outline:

- Introduction to refrigeration and air conditioning
- Vapour compression refrigeration systems
- Refrigerants
- Multi-pressure systems
- Refrigeration system components
- Absorption system of refrigeration
- Psychrometry
- Summer and winter AC
- Load calculations

5. Study Materials:

Text Books:

- C.P. Arora, Refrigeration and Air Conditioning, Tata McGraw-Hill.
- R.J. Dossat, Principles of refrigeration, Pearson.

Reference Books:

- W.F. Stoecker, Refrigeration and Air conditioning, Tata McGraw-Hill.
- P.N. Ananthanarayanan, Basic Refrigeration and Air Conditioning, Tata McGraw-Hill.
- M. Prasad, Refrigeration and Air Conditioning, New Age International Pvt Ltd Publishers.

MEL 1806: Tribology

1. Course Description:

Introduction to tribology, History of tribology, Interdisciplinary Approach, Economic Benefits. Causes of Friction, Adhesion Theory, Abrasive Theory, Junction Growth Theory, Laws of Rolling Friction, and Friction Instability. Wear Mechanisms, Adhesive Wear, Abrasive Wear, Corrosive Wear, Fretting Wear. Importance of Lubrication, Boundary Lubrication, Mixed Lubrication, Full Fluid Film Lubrication; Hydrodynamic, Elasto-hydrodynamic lubrication, Types & Properties of Lubricants, Lubricants Additives. Application of Tribology: Rolling contact bearings, Gears and Journal bearings.

2. Pre-requisite:

Fluid Mechanics (MEL 1302)

3. Course Outcomes (COs):

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

- Understand the importance of tribology
- Understand Law of friction and wear theory
- Understand lubrication, types and application
- Understand application of tribology

4. Broad Course Outline:

- Introduction
- Friction
- Wear
- Lubrication and Lubricants
- Application of Tribology

5. Study Materials:

Text Books

- Dowson D, History of Tribology, Longman London.
- Stachowiak G N, Batchelor A W and Stachowick G B "Experimental methods in Tribology", Tribology Series 44, Editor D Dowson.
- Michael M Khonsari, Applied Tribology (Bearing Design and Lubrication),John Wiley & Sons.
- Jost H P, Lubrication (Tribology): A Report on the present position and industry`s needs, Her Majesty`s Stationary Office, London.
- J Halling, Principles of Tribology, The Macmillan Press Ltd, London.

Reference Books

- Archard J F and Hirst W, The Wear of Metals under Unlubricated Conditions, Proc. R. Soc., London, A 236, 397-410.
- Ludema K C, Friction, Wear, Lubrication: A textbook in Tribology, CRC Press.
- Lim S C and Ashby M F, Wear Mechanism Maps, Acta Metall., Vol. 35 (1), 1-24, 1987.
- Waterhouse R B, Fretting Wear, Wear Vol. 100(1-3), 107118, 1984**.**

MEL1807: Product Design and Manufacturing

1. Course Description:

Innovation, better management, throughput improvements, and expansion of new technologies. Managing the product development process: Idea generation to final product manufacturing, Understanding customer needs, Time-to-market constraint. Product design and development process from manufacturing systems aspects. Design for Manufacturing: Assembly, Environment, Analytical tools for development. Costing and manufacturing: Conceptualization, Design, and manufacture competitively-priced quality products. Reverse Engineering, Prototyping and Simulation using soft tools, Advanced methods in manufacturing.

2. Pre-requisites:

Manufacturing Science and Technology (MEL1405)
Machine Design- I (MEL1504)

3. Course Outcomes (COs):

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

- Illustrate the mechatronics system and its components construction, application.
- Analysis of sensor application, construction operation.
- Describe actuator system components like, hydraulic, pneumatic, electrical actuating systems.
- Design hydraulic, pneumatic and electric circuit for mechatronic systems.
- Design controller for mechatronics system.
- Apply data acquisition system and microcontroller system and control.

4. Broad Course Outline:

- Introduction
- Product Design Morphology
- Visual Design, and Quality Function Development
- Value Engineering
- Material and Manufacturing process selection
- Design of Manufacturing, Assembly and Maintenance
- Rapid Prototyping
- Plant Layout Design

- Reverse Engineering and managing Competitiveness

5. Study Materials:

Text Books

- Eppinger, S. and Ulrich, K., 2015. Product design and development. McGraw-Hill Higher Education
- Magrab, E.B., Gupta, S.K., McCluskey, F.P. and Sandborn, P., 2009. Integrated product and process design and development: the product realization process. CRC Press.

Reference Books

- Boothroyd, G., 1994. Product design for manufacture and assembly. Computer-Aided Design, 26(7), pp505-520.

MEL1808: Innovation and Entrepreneurship

1. Course Description:

Introduction: Evolvement of entrepreneurship from economic theory, Entrepreneurship and characteristics of entrepreneurs, Need for education on entrepreneurship, Competency and entrepreneurial competencies. Creativity as a prerequisite to innovation, Innovation and entrepreneurship. Self-assessment and window Self-reflecting self- awareness, Decision-making, Leadership, Motivation. Concept of a planning paradigm for a new venture, Founstase growth model, Fundamentals of feasibility plan. An introduction to patents, trademarks and spy rights, intellectual property right, Business opportunity identification, Need, scope and characteristics of a small scale business industry. Marketing concept, Fundamentals of marketing, Distribution, Promotion, Pricing, Marketing strategy, Break-even analysis. Total quality management, ISO standards, Management information system, Concept of Intellectual Property Right (IPR), Patent, Copyright, and Trademark. Project planning and preliminary project report.

2. Pre-requisite:

Open to all engineering disciplines.

All courses in B. Tech 1st and 2nd semester.

3. Course Outcomes (COs):

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

- Differentiate between Entrepreneur and Intrapreneur and appraise the importance of entrepreneurship in economic growth.
- Justify the need, and objectives of Entrepreneurship Development Programs.
- Appraise the steps involved in setting up a business and business project reports.
- Justify the need of financing and accounting.

3. Broad Course Outline:

- Introduction
- Entrepreneurship and characteristics of entrepreneurs
- Need for education on entrepreneurship
- Concept of a planning paradigm for a new venture
- Marketing concept

4. Study Materials:

Text Books

- Shankar, Entrepreneurship: Theory & Practice, McGraw-Hill
- Hirsch, Entrepreneurship, McGraw-Hill, (Special Indian Edition).

Reference Books

- A.K. Singh, Entrepreneurship Development & Management, Laxmi Publication
- David H. Holt, Entrepreneurship: New venture creation, Prentice Hall Publication

MEL1809: Fuzzy Systems and Genetic Algorithms

1. Course Description:

Different faces of imprecision – inexactness, ambiguity, undecidability, Fuzziness and certainty, Fuzzy sets, and crisp sets. Intersection of Fuzzy sets, Union of Fuzzy sets - the complement of Fuzzy sets-Fuzzy reasoning. Linguistic variables, Fuzzy propositions, Fuzzy compositional rules of inference - Methods of decompositions and defuzzification. Methodology of fuzzy design - Direct & Indirect methods with single and multiple experts, Applications– Fuzzy controllers - Control and Estimation. Genetic Algorithms- basic structure-coding steps of GA, convergence characteristics, applications.

2. Pre-requisite:

Engineering Mathematics I (MAL 1101)
Engineering Mathematics I (MAL 1202)

3. Course Outcomes (COs):

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

- Understand Classical Relations and Fuzzy Relations
- Know about Fuzzy Rule Base and Approximate Reasoning: Truth values and Tables in Fuzzy logic
- Gain knowledge about Traditional Algorithm vs. Genetic Algorithm

3. Broad Course Outline:

- Introduction
- Introduction to Classical Sets and Fuzzy sets
- Fuzzy Arithmetic and Fuzzy Measures
- Introduction to Genetic Algorithm

4. Study Materials:

Text Books

- Timothy J. Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill.
- Goldberg, Genetic Algorithms, Pearson Education India.

Reference Books

- George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic -Theory and Applications, Pearson Education India.
- Dilip K. Prathar, Soft computing Fundamentals and Application, Norasa Publications.

MEL 1810: Project Management

1. Course Description:

Theoretical framework for managing projects: Introduction to project management, agile project management, and project management processes. Risk management in projects: Project stakeholder and risk management, solving project management decision problems, and project risk management analysis. Project management and decision analysis: Analytic hierarchy process for project selection, decision tree analysis, application of utility theory, project selection criteria, work breakdown structure, and activity networks. Project scheduling and control: CPM and PERT, project life cycle, discounting rates and project pricing, forward rates and payback time, probabilistic time and variance, scheduling and crashing of jobs, resource levelling and resource constraint. Earned value management and GERT: Project scheduling and crashing, earned value management, Graphical Evaluation and Review Technique (GERT), critical chain, and theory of constraint.

2. Pre-requisites:

Prior knowledge of the following subject:

- Operation Research (MAL16XX)

3. Course Outcome:

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

- Understand the general and advanced concepts of project management.
- Solve project management decision problems.
- Understand the analytic hierarchy process for project selection.
- Apply CPM and PERT for project scheduling and control.
- Understand Earned value management in projects.
- Apply Graphical Evaluation and Review Technique

4. Broad Course Outline:

- Introduction to project management, project management cycle
- Risk associated with projects decision.
- Cost evaluation techniques
- PERT, CPM; project life cycles
- Project scheduling; GERT
- Q-GERT; critical chain and theory of constraints

- Activity network diagram, resource requirement, resource constraints, crashing of jobs.
- Project control techniques; earned value management.

5. Study Materials:

Text Books:

- P. Chandra, Projects: Planning, Analysis, Selection, Financing, Implementation, and Review, McGraw Hill.
- J.D. Weist, A Management Guide to PERT-CPM: With GERT-PDM-DCPM and other Networks, Prentice Hall India Learning Private Limited.
- D.L. Cleland, and L.R. Ireland, Project Management: Strategic Design and Implementation, McGraw Hill.
- G. Horine, Project Management Absolute Beginner's Guide, Que Publishing.

Reference Books:

- Project Management Institute, A guide to the Project Management Body of Knowledge, Project Management Institute.
- K. Schwaber, Agile Project Management with Scrum, Microsoft Press.