B. TECH. MECHANICAL ENGINEERING (2nd YEAR)

Total Contact Hours = 34 Total Marks = 1100 Total Credits = 26

SEMESTER 3rd		Contact Hrs			Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
BMEE1- 301	Strength of Material-I	3	1	0	40	60	100	4
BMEE1-302	Theory of Machines-I	3	1	0	40	60	100	4
BMEE1-303	Machine Drawing using CAD	1	0	4	40	60	100	3
BMEE1-304	Applied Thermodynamics-I	3	1	0	40	60	100	4
BMEE1-305	Manufacturing Processes	2	0	0	40	60	100	2
BSOS0-F91	Soft Skill - I	0	0	2	60	40	100	1
BMEE1-306	*Workshop Training	0	0	4	60	40	100	2
BMEE1-307	Strength of Material Lab.-I	0	0	2	60	40	100	1
BMEE1-308	Applied Thermodynamics Lab--I	0	0	2	60	40	100	1
BMEE1-309	Manufacturing Processes Lab	0	0	2	60	40	100	1
Department Elective - I		3	0	0	40	60	100	3
BMEE1-356	Non - Conventional Energy Recourses							
BMEE1-357	Industrial Engineering							
BMEE1-358	Product Design and Development							
Total	**Theory = 6 Labs = 4**	**15**	**3**	**16**	**540**	**560**	**1100**	**26**

**Workshop training will be imparted in the institution at the end of 2nd semester for four-week duration*

(Minimum 36 hrs. per week) industrial tour will also from the part of this training.

Total Contact Hours = 32 Total Marks = 1100 Total Credits = 27

SEMESTER 4th		Contact Hrs			Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
BMEE1- 410	Strength of Material-II	3	1	0	40	60	100	4
BMEE1- 411	Theory of Machines-II	3	1	0	40	60	100	4
BMEE1- 412	Fluid Mechanics	3	1	0	40	60	100	4
BMEE1- 413	Applied Thermodynamics-II	3	1	0	40	60	100	4
BMEE1- 414	Material Science & Metallurgy	3	0	0	40	60	100	3
BSOS0 – F92	Soft Skill – II	0	0	2	60	40	100	1
BMEE1- 415	Theory of Machines-II Lab	0	0	2	60	40	100	1
BMEE1- 416	Fluid Mechanics Lab	0	0	2	60	40	100	1
BMEE1- 417	Applied Thermodynamics-II Lab	0	0	2	60	40	100	1
BMEE1- 418	Material Science & Metallurgy Lab.	0	0	2	60	40	100	1
Department Elective - II		3	0	0	40	60	100	3
BMEE1- 459	Composite Material							
BMEE1- 460	Welding Technology							
BMEE1- 461	Materials Management							
Total	**Theory = 6 Labs = 5**	**18**	**4**	**10**	**540**	**560**	**1100**	**27**

Total Contact Hours = 27 Total Marks = 1200 Total Credits = 24

SEMESTER 5th		Contact Hrs			Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
BMEE1- 519	Design of Machine Element-I	2	0	0	40	60	100	2
BMEE1- 520	Mechanical Measurement and Metrology	3	0	0	40	60	100	3
BMEE1- 521	Automobile Engineering	3	0	0	40	60	100	3
BMEE1- 522	Industrial Automation & Robotics	3	0	0	40	60	100	3
BSOS0 –F93	Soft Skill – III	0	0	2	60	40	100	1
BMEE1- 523	Design of Machine Element-I Lab	0	0	2	60	40	100	1
BMEE1- 524	Mechanical Measurement and Metrology Lab.	0	0	2	60	40	100	1
BMEE1- 525	Automobile Engineering Lab	0	0	2	60	40	100	1
BMEE1- 526	Industrial Automation & Robotics Lab.	0	0	2	60	40	100	1
BMEE1-527	*Industrial Training	0	0	0	60	40	100	2
Department Elective – III		3	0	0	40	60	100	3
BMEE1-562	Fluid Mechanics-II							
BMEE1-563	Tool Design							
BMEE1-564	Finite Element Method							
Open Elective – I		3	0	0	40	60	100	3
Total	**Theory = 6 Labs = 5**	**17**	**0**	**10**	**600**	**600**	**1200**	**24**

**Industrial training to be imparted at the end of 4th semester for six weeks*

Total Contact Hours = 27 Total Marks = 1000 Total Credits = 23

SEMESTER 6th		Contact Hrs			Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
BMEE1- 628	Design of Machine Element-II	2	0	0	40	60	100	2
BMEE1- 629	Heat Transfer	3	1	0	40	60	100	4
BMEE1- 630	Fluid Machinery	3	1	0	40	60	100	4
BSOS0 – F94	Soft Skill - IV	0	0	2	60	40	100	1
BMEE1- 631	Design of Machine Element-II Lab	0	0	2	60	40	100	1
BMEE1- 632	Heat Transfer Lab	0	0	2	60	40	100	1
BMEE1- 633	Fluid Machinery Lab	0	0	2	60	40	100	1
Department Elective – IV (Select any one)		3	0	0	40	60	100	3
BMEE1-665	Operation Management							
BMEE1-666	Industrial Tribology							
BMEE1-667	Modelling & Simulation							
BMEE1-668	Mechatronics							
Department Elective – V (Select any one)		3	0	0	40	60	100	3
BMEE1-669	Management Information System							
BMEE1-670	Solar Energy							
BMEE1-671	Energy Conservation & Management							
BMEE1-672	Industrial Automation and Robotics							
Open Elective – II (Select any one)		3	0	0	40	60	100	3
Total	**Theory = 6 Labs = 4**	**17**	**2**	**8**	**480**	**520**	**1000**	**23**

Total Contact Hours = 18 **Total Marks = 600** **Total Credits = 15**

SEMESTER 7th		Contact Hrs			Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
BMEE1-734	Refrigeration & Air Conditioning	3	1	0	40	60	100	4
BMEE1-735	Refrigeration & Air Conditioning Lab.	0	0	2	60	40	100	1
BMEE1-736	Project	0	0	6	60	40	100	2
BMEE1- 737	*Industrial Training	0	0	0	60	40	100	2
Department Elective – VI (Select any one)		3	0	0	40	60	100	3
BMEE1-773	Mechanical Vibration							
BMEE1-774	Non Traditional Manufacturing							
BMEE1-775	Heat Exchanger Design							
Department Elective – VII (Select any one)		3	0	0	40	60	100	3
BMEE1-776	Maintenance Engineering							
BMEE1-777	Non Destructive Testing							
BMEE1-778	Automotive Control							
Total	**Theory = 4 Labs = 2**	**9**	**1**	**8**	**300**	**300**	**600**	**15**

**The industrial Training to be imparted at the end of 6th semester for Eight weeks*

Total Contact Hours = 15 **Total Marks = 500** **Total Credits = 15**

SEMESTER 8th		Contact Hrs			Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
BMEE1-838	CAD/CAM	3	1	0	40	60	100	4
BMEE1-839	Operation Research	3	1	0	40	60	100	4
BMEE1-840	Seminar	0	0	2	100	0	100	1
Department Elective – VIII (Select any one)		3	0	0	40	60	100	3
BMEE1-879	Optimization Technique							
BMEE1-880	Lean Manufacturing							
BMEE1-881	Group Technology							
Department Elective – IX (Select any one)		3	0	0	40	60	100	3
BMEE1-882	Statistical Quality Control							
BMEE1-883	Additive Manufacturing							
Total	**Theory = 4 Labs = 1**	**12**	**1**	**2**	**260**	**240**	**500**	**15**

Total Credits: 25 + 25 + 26 + 27 + 24 + 23 + 15 + 15 = 180

STRENGTH OF MATERIALS – I

Subject Code: BMEE1- 301 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Course Objective/s and Expected Outcome/s: The course is designed to understand the basic concepts of stress, strain and their variations due to different type of loading. The concept of mechanical properties, Poisson's ratio, bulk modulus, elastic modulus, modulus of rigidity, combined stress and strain, principal stress, principal plane, bending moment and shear force in beams under various loading conditions, understanding of torsional shear stress in solid and hollow shaft; principal and maximum shear stress in a circular shaft subjected to combined stresses, forces and reactions in frames, stresses in struts and columns subjected to axial load; bending stress, slope and deflection under different loading and supporting conditions.
After studying the course, the student will be able to analyze different stresses, strains and deflection for designing a simple mechanical element e.g. beams, shafts, columns and frames under various loading conditions.

UNIT-I (12 Hrs.)

Stresses and Strains: Basic definitions: Stress and strain and their types, fatigue, creep, ductility, brittleness, hardness, toughness, impact strength, stress concentration, Hook's law, longitudinal and lateral strain, Poisson's ratio, stress-strain diagram for ductile and brittle materials, extension of a bar with or without self-weight, bar of uniform strength, elastic constants and their significance, Young's modulus of elasticity, modulus of rigidity and bulk modulus, thermal stress and strain in single and compound bars. Two dimensional stress system, stress at a point on a plane, principal stresses and principal planes, Mohr's circle of stress. Generalized Hook's law, principal stresses related to principal strains.

UNIT-II (11 Hrs.)

Bending Moment (B.M) and Shear Force (S.F.) Diagrams: S.F and B.M definitions; relation between load, shear force and bending moment; B.M and S.F diagrams for cantilevers, simply supported beams with or without overhangs, and calculation of maximum B.M and S.F and the point of contra flexure under the following loads:
a) Concentrated loads
b) Uniformly distributed loads over the whole span or part of span
c) Combination of concentrated and uniformly distributed load
d) Uniformly distributed load (optional)
e) Application of moments
Bending Stresses in Beams: Derivation of bending equation and its application to find stresses in beams of rectangular, circular and channel, I and T- sections. Flexural Rigidity, combined direct and bending stresses in afore-mentioned sections, stresses in composite / flitched beams**.**

UNIT–III (12 Hrs.)

Slope and Deflection: Relationship between moment, slope and deflection; double integration method, Macaulay's method and use of these methods to calculate slope and deflection for:
a) Cantilevers
b) Simply supported beams with or without overhang
c) beams under concentrated loads, uniformly distributed loads and their combination.
Columns and Struts: Introduction of columns and struts, end conditions, failure of columns, Euler's formula, empirical formulas to find buckling load.

UNIT-IV (10 Hrs.)

Torsion: Derivation of torsion equation and its application to the hollow and solid circular shafts. Torsional rigidity, Angle of twist, combined torsion and bending of circular shafts; Principal stress and maximum shear stresses under combined loading of bending and torsion.

Frames: Introduction and types of frames, assumptions made in finding out the forces in frame, reactions of the supports of a frames, analysis of frames: method of joints, method of sections, graphical methods and its applications.

Recommended Books

1. Sadhu Singh, 'Strength of Materials', Khanna Publishers.
2. Kirpal Singh, 'Mechanics of Materials', Standard Publishers.
3. G.H. Ryder, 'Strength of Materials', Macmillan India Ltd.
4. S.S. Rattan, 'Strength of Materials', Tata McGraw Hills.
5. Timoshenko and Gere, 'Mechanics of Materials', CBS Publishers.
6. E.P. Popov, 'Mechanics of Materials', Pearson Education.

THEORY OF MACHINES-I

Subject Code: BMEE1-302 **L T P C** **3 1 0 4** **Duration: 45 Hrs.**

Learning Objectives & Learning Outcomes:

The course under Theory of Machine-I has been designed to cover the basic concepts of kinematic aspects of mechanical machines and major parts used in running of the machines. The students will understand the basic concepts of machines and able to understand constructional and working features of important machine elements. The students should be able to understand various parts involved in kinematics of machines. The students shall also be able to understand requirements of basic machine parts which would help them to understand the design aspects of the machine parts

UNIT-I (12 Hrs.)

Basic Concept of Machines: Link, Mechanism, Kinematic Pair and Kinematic Chain, Principles of Inversion, Inversion of a Four Bar Chain, Slider-Crank-Chain and Double Slider-Crank-Chain. Graphical and Analytical methods for finding: Displacement, Velocity, and Acceleration of mechanisms.

Belts, Ropes and Chains: Flat and V-belts, Rope & Chain Drives, Idle Pulley, Intermediate or Counter Shaft Pulley, Velocity Ratio, Crowning of Pulley, Loose and fast pulley, stepped or cone pulleys, ratio of tension on tight and slack side of belts, Length of belt, Power transmitted by belts, Creep and Slip, Centrifugal Tensions

UNIT-II (11 Hrs.)

Cams: Types of cams and follower, definitions of terms related with cams. Displacement, velocity and acceleration diagrams for cam followers. Analytical and Graphical design of cam profiles with various motions (SHM, uniform velocity, uniform acceleration and retardation, cycloidal Motion).

UNIT-III (11 Hrs.)

Friction Devices: Types of brakes function of brakes. Braking of front and rear tyres of a vehicle, Determination of braking capacity, Types of dynamometers, (absorption, and transmission).

Flywheels: Turning moment and crank effort diagrams for reciprocating machines' Fluctuations of speed, coefficient of fluctuation of speed and energy, Determination of mass and dimensions of flywheel.

UNIT-IV (11 Hrs.)

Governors: Function, Porter and Proell governors, Hartnell and Willson-Hartnell spring loaded governors, Sensitivity, stability, isochronism and hunting of governor, Governor effort and power, controlling force curve, effect of sleeve friction.

Recommended Books

1. S.S. Rattan, 'Theory of Machines', Tata McGraw Hill, New Delhi.
2. Jagdish Lal, 'Theory of Machines and Mechanisms', Metropolitan Book Co.
3. V.P. Singh, 'Theory of Machines', Dhanpat Rai Publication.

MACHINE DRAWING USING CAD

Subject Code: BMEE1-303 **L T P C** **Duration: 43 Hrs.**
1 0 4 3

UNIT-I (10 Hrs.)

Introduction to Mechanical Drawing: Classification of drawings, Principles of drawing, Conventions according to IS, Sectional Views and rules of sectioning, Machining and Surface Finish symbols indicating tolerances in dimensioning, Detailed Drawings. Manual Drafting and Computer Aided Drafting using s/w like Pro-desktop or Pro-E or AutoCAD, Standards and Types.

UNIT-II (08 Hrs.)

Machine Components: Practical applications and working of Screw fasteners, Keys cotters and joints, Shaft couplings, Pipe joints and fittings, Riveted joints and welded joints.

UNIT-III (11 Hrs.)

Assemblies: Bearings (Plumber Block, Footstep, Swivel), Hangers and Brackets, Steam and I.C. Engine Parts, Machine components, Valves.

Case Studies in Computer Plots and Industrial Blueprints.

UNIT-IV (14 Hrs.)

Computer Aided Drafting (CAD)

Using s/w like Pro-E or AutoCAD) of:

(a) Machine Components: Screw fasteners, Keys cotters and joints, Shaft Couplings, Pipe joints and fittings, Riveted joints and welded joints.
(b) Assemblies: Bearings (Plumber Block, Footstep, Swivel), Hangers and Brackets, Engine Parts, Machine components, Valves. Exercise in computer plots of drawings/ blueprints.

Learning Outcomes

The students will be able to:

1. Use standards used in machine drawing of machine components and assemblies.
2. Create and read production drawings for mechanical components and systems and deduce their functions.
3. Use CAD tools for making drawings of machine components and assemblies.
4. Assemble components given only component drawings and make

Sectioned views of the mechanical system assembly and interpret it's working.

Recommended Books

1. P.S. Gill, 'Machine Drawing', S.K. Kataria and Sons, **2013.**
2. N.D. Bhatt, 'Machine Drawing', Charotar Publishing House, **2008.**
3. G. Pohit, 'Machine Drawing with AutoCAD', Pearson Education Asia, **2007.**
4. R.K. Dhawan, 'Machine Drawing', S. Chand & Company Limited, **2003.**
5. K.L. Narayana, P. Kannaiah and K.V. Reddy, 'Machine Drawing', New Age International Publishers, **2002.**

APPLIED THERMODYNAMICS –I

Subject Code: BMEE1-304 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Unit –I

Combustion

Combustion Equations (Stoichiometric and non- Stoichiometric). Combustion problems in Boilers and IC engines/Calculations of air fuel ratio, Analysis of products of combustion, Conversion of volumetric analysis into gravimetric analysis and vice-versa, Actual weight of air supplied, Use of mols, for solution of combustion problems, Heat of formation, Enthalpy of formation, Enthalpy of reaction, Adiabatic flame temperature.

IC Engines

Introduction: Actual Engine Indicator diagrams and valve-timing diagrams for two stroke and four stroke S.I. and C.I. Engines; Construction and Working Principle of Wankel rotary engine; Principle of simple carburator, Injection systems in Diesel and Petrol Engines (Direct Injection, MPFI in SI and CI Engines, respectively). Essential requirements for Petrol and Diesel Fuels. Theory of combustion in SI and CI Engines; Various stages of combustion; Pressuretime/crank - Angle diagrams; Various phenomenon such as turbulence, squish and swirl, dissociation, pre-ignition/auto- ignition, and after burning etc.; Theory of knocking (ie,. detonation) in SI and CI Engines; Effect of engine variables on the Delay Period in SI and CI engines; Effect of various parameters on knock in SI and CI Engines; Methods employed to reduce knock in SI and CI Engines; Octane and Cetane rating of fuels; Knockmeter; Dopes and inhibitors; Performance curves/maps of SI and CI Engines; Effect of knocking on engine performance; Effect of compression ratio and air-fuel ratio on power and efficiency of engine; Variation of engine power with altitude; Supercharging and turbo charging of SI and CI Engines; Advantages and applications of supercharging.

Unit –II

Properties of Steam

Pure substance; Steam and its formation at constant pressure: wet, dry, saturated and super-heated steam; Sensible heat(enthalpy), latent heat and total heat (enthalpy) of steam; dryness fraction and its determination; degree of superheat and degree of sub-cool; Entropy and internal energy of steam; Use of Steam Tables and Mollier Chart; Basic thermodynamic processes with steam (isochoric, isobaric, isothermal, isentropic and adiabatic process) and their representation on T-S Chart and Mollier Charts(h-s diagrams). Significance of Mollier Charts.

Steam Generators

Definition: Classification and Applications of Steam Generators; Water Tube, Fire Tube and Super Critical boilers. Advantages of forced circulation; Description of boiler mountings and

accessories; Boiler performance: equivalent evaporation, boiler efficiency, boiler trial and heat balance; Types of draught and Calculation of chimney height.

Unit –III

Vapour Power Cycle

Carnot Cycle and its limitations; Rankine steam power cycle, Ideal and actual; Mean temperature of heat addition; Effect of pressure, temperature and vacuum on Rankine Efficiency; Rankine Cycle Efficiency and methods of improving Rankine efficiency: Reheat cycle, Bleeding (feed-water-heating), Regenerative Cycle, Combined reheat-regenerative cycle; Ideal working fluid; Binary vapour cycle, Combined power and heating cycles.

Steam Nozzles

Definition, types and utility of nozzles; Flow of steam through nozzles; Condition for maximum discharge through nozzle; Critical pressure ratio, its significance and its effect on discharge; Area of throat and at exit for maximum discharge; Effect of friction; Nozzle efficiency; Convergent and convergent-divergent nozzles; Calculation of Nozzle dimensions (length and diameters of throat and exit); Supersaturated (or metastable) flow through nozzle.

Unit –IV

Steam Turbines

Introduction; Classification; Impulse versus Reaction turbines. Simple impulse turbine: pressure and velocity variation, Velocity diagrams/triangles; Combined velocity diagram/triangle and calculations for force, axial thrust, work, power, blade efficiency, stage efficiency, maximum work and maximum efficiency, effect of blade friction on velocity diagram, effect of speed ratio on blade efficiency, condition for axial discharge of simple Impulse and Reaction Turbine.

Compounding of impulse turbine, Degree of reaction, combined velocity diagram/triangle and calculations for force, axial thrust, work, power, blade efficiency, stage efficiency, overall efficiency and relative efficiency, maximum work and maximum efficiency; Calculations of blade height; Multistaging: Overall efficiency and relative efficiency; Reheating, Reheat factor and condition curve; Losses in steam turbines; Back pressure and extraction turbines; Co-generation; Governing of steam turbines.

Steam Condensers

Function; Elements of condensing unit; Types of condensers; Dalton's law of partial pressures applied to the condenser problems; Condenser and vacuum efficiencies; Cooling water calculations; Effect of air leakage; Method to check and prevent air infiltration; Description of air pump and calculation of its capacity.

Recommended Books:

1. R. Yadav, Sanjay and Rajay, Applied Thermodynamics, Central Publishing House.
2. J.S. Rajadurai, Thermodynamics and Thermal Engineering, New Age International (P) Ltd. Publishers.
3. D.S. Kumar and V.P. Vasandani, 'Heat Engineering', Metropolitan Book Co. Pvt. Ltd.
4. K. Soman, 'Thermal Engineering', PHI Learning Pvt. Ltd.
5. G. Rogers and Y. Mayhew, 'Engineering Thermodynamics', Pearson.
6. W.A.J. Keartan, 'Steam Turbine: Theory and Practice', ELBS Series.
7. Heywood, 'Fundamentals of IC Engines', McGraw Hill.
8. V. Ganeshan, Internal Combustion Engines, Tata McGraw Hill.

MANUFACTURING PROCESSES

Subject Code: BMEE1-305 **L T P C** **Duration: 43 Hrs.**
3 1 0 4

Learning Objectives: To expose the students to the principles of the metal joining methods with principle of operations and power sources for different welding techniques, process parameters and their effects on joint quality, joint quality checking, weld ability issues. To impart the knowledge on metal cutting mechanics, cutting force, stress, strain etc., effect of process parameters, grinding and abrasive machining techniques. To study metal forming techniques, extrusion, rolling, drawing, and sheet metal forming and shearing operations, some design aspects and knowledge about process behavior.

UNIT –I (11 Hrs.)

Metal Casting: Review of sand casting, sand testing, machine moulding, inspection of castings, casting defects; Shell moulding; investment casting; die casting; centrifugal casting. Elements of gating system and risers and their design, Design considerations of castings, Cores: function, types, core making process, core-prints, chaplets.

Welding: Review of welding processes, weldability, principles and application of TIG and MIG welding, Advanced welding processes: friction stir welding, ultrasonic welding, laser beam welding, plasma arc welding, electron beam welding.

UNIT-II (12 Hrs.)

Metal Forming: Hot and cold forming, forming processes, forging machines, forging design considerations, forging defects; High energy rate forming processes. Press working: press types, operations, press tools, progressive and combination dies.

Shaping Non-Metallic Materials: Basic manufacturing processes for processing of plastics and ceramics.

Powder Metallurgy: Introduction, advantages, limitations, and applications methods of producing metal powders, briquetting and sintering.

UNIT-III (11 Hrs.)

Metal Cutting: Introduction to machining processes, classification, Mechanics of chip formation process, concept of shear angle, chip contraction and cutting forces in metal cutting, Merchant theory, tool wear, tool life, machinability. Numerical problems based on above mentioned topics, Cutting tools: types, geometry of single point cutting tool, twist drill and milling cutter, tool signature. Cutting tool materials: high carbon steels, alloy carbon steels, high speed steel, cast alloys, cemented carbides, ceramics and diamonds, and CBN.

UNIT –IV (10 Hrs.)

Machine Tools: Classification, description and operations of lathe, kinematic scheme of lathe, Shaper, planer, classification, milling machine, Drilling machine. Grinding machines: wheel selection, grinding wheel composition and nomenclature of grinding wheels, dressing and truing of grinding wheels.

WORKSHOP TRAINING

Subject Code: BMEE1-306 **L T P C** **Duration: 36 Hrs.**
0 0 4 2

Workshop/Institutional Training will be imparted in the institutional workshop and respective departmental labs at the end of 2nd Semester for 4-Week duration (Minimum 36 hours per week).

The objective is to provide intensive training to the students in respect of different manufacturing practices and developing familiarity with their concerned stream. Industrial tour will be part of this training.

MANUFACTURING PROCESSES LAB.

Subject code: BMEE1-309 **L T P C**
0 0 2 1

List of Experiments

Sand Testing Shop

1. Determination of the clay content in a sample of moulding sand.
2. Estimation of moisture content of the sample of green sand using Rapid Moisture teller / Rapid Drier.
3. To determine shatter index of the moulding sand.
4. To determine the permeability of a given sample of green sand and dried sand.
5. Determination of mould / core hardness using portable and sand hardness tester.
6. To prepare the green sand for sand moulding, Study of mechanical sand rammer for sand moulding. Relationship between mulling time & green strength, percentage clay contains and green compressive strength.

Foundry Shop

1. Study of casting defects and remedies.

Machine Shop

1. Spur Gear cutting on Milling Machine.
2. Demonstration on milling machine: Up & Down milling.
3. Demonstration on Shaper, Drilling machines.

Welding Shop

1. Demonstration on arc welding processes.
2. Testing the strength of a welded joint using MIG welding.
3. Demonstrations of various Resistance Welding Techniques.

Learning Outcomes:

After studying this course, students shall be able to:

1. To understand the basic concepts of sand testing.
2. To understand working of various machine tools.
3. To use various welding processes.

NON-CONVENTIONAL ENERGY RESOURCES

Subject Code: BMEE1-356 **L T P C** **Duration: 38 Hrs.**
3 0 0 3

UNIT-1

Introduction: Renewable and non-renewable energy sources, their availability and growth in India; Energy consumption as a measure of Nation's development; strategy for meeting the future energy requirements.

Solar Energy: Solar radiation - beam and diffuse radiation; earth sun angles, attenuation and measurement of solar radiation; Optical properties of materials and selective surfaces; Principles, general description and design procedures of flat Platte and concentrating collectors;

Performance analysis of cylindrical and parabolic collectors; Solar energy storage systems - their types, characteristics and capacity; solar ponds. Applications of solar energy in water, space and process heating, solar refrigeration and air conditioning; water desalination and water pumping; solar thermal power generation; solar cells and batteries; economic analysis of solar systems.

UNIT-II

Wind Energy: Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of aerodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations.

UNIT-III

Direct Energy Conversion Systems:

(i) Magnetic Hydrodynamic (MHD) Generator: gas conductivity and MHD equations; operating principle, types and working of different MHD systems – their relative merits; MHD materials and production of magnetic fields.

(ii) Thermo-electric generators: Thermo-electric effects and materials; thermo-electric devices and types of thermo-electric generators; thermo-electric refrigeration.

(iii) Thermionic generators: thermionic emission and materials; working principle of thermionic convertors.

(iv) Fuel Cells: thermodynamic aspects; types, components and working of fuel cells.

(v) Performance, applications and economic aspects of above mentioned direct energy conversions systems.

UNIT-IV

Miscellaneous Non-Conventional Energy Systems:

(i) Bio-mass: Concept of bio-mass conversion, photo-synthesis and bio-gasification; Bio gas generators and plants - their types, constructional features and functioning; digesters and their design; Fuel properties of bio gas and community bio gas plants

(ii) Geothermal: Sources of geothermal energy - types, constructional features and associated prime movers.

(iii) Tidal and Wave Energy: Basic principles and components of tidal and wave energy plants; single basin and double basin tidal power plants; conversion devices Advantages / disadvantages and applications of above mentioned energy systems.

Recommended Books

1. H.P. Garg and Jai Prakash, 'Solar Energy: Fundamentals and Applications', Tata McGraw Hill.
2. S.P. Sukhatme, 'Solar Energy: Principles of Thermal Collection and Storage', Tata McGraw Hill.
3. John A. Duffic and W.A. Beckman, 'Solar Engineering of Thermal Processes', John Wiley.
4. S.L. Sheldon, Chang, 'Energy Conversion', Prentice Hall.
5. O.M. Bockris and S. Srinivasan, 'Fuel Cells', McGraw Hill.
6. G.D. Rai, 'Non-Conventional Energy Sources', Khanna Publishers, New Delhi.
7. B.H. Khan, 'Non-Conventional Energy', Tata McGraw-Hill, New Delhi.
8. Ashok V. Desai, 'Nonconventional Energy', New Age International Publishers Ltd.

INDUSTRIAL ENGINEERING

Subject Code: BMEE1-357 **L T P C** **Duration: 38 Hrs.**
3 0 0 3

UNIT-I

Introduction to Industrial Engineering
Relevance of industrial engineering for achieving performance excellence in industry.
Productivity Management: Productivity measurement and improvement, Resource waste minimization, Lean manufacturing.
Plant Location & Layout: Factors effecting plant location, Selection of plant site, Quantitative techniques of plant location decision, Plant layout, Principles of layout design, Methods for evaluation of a layout, Quantitative techniques of developing layouts.

UNIT-II

Materials Management: Objectives and functions, Procurement, Types of inventories, Inventory costs, Inventory control models, Determination of EOQ (under deterministic conditions), MRP, Bill of materials.
Product Engineering: Product design considerations, Product development, Detailing, Value Engineering and its role in product design and cost rationalization.

UNIT-III

Work Science: Purpose and scope, Productivity and work-study, Method Study and Work Measurement, Principles of Motion Economy, Elements of Work Sampling, Predetermined Motion Time Systems, Principles of Work Design.
Ergonomics: Role of Ergonomics in industry, Introduction to anthropometry, Task analysis to reduce Musclo-Skeletal disorders, Posture analysis, Introduction to bio-mechanics, Effect of physical environment on performance.

UNIT-IV

Maintenance Management: Objectives, Nature of maintenance problems, Maintenance strategies, Organization, Maintenance Information Systems, Spare Parts Management, Maintenance Cost Control, Introduction to Total Productive Maintenance.

Learning Outcomes:
The students will be able to
1. Evaluate and improve the business process for effective utilization of all the industrial resources.
2. Manage and plan the general inventory in industry.
3. Develop better methods for workplace improvement and new products.
4. To develop improved techniques/methods.

Recommended Books
1. R. Shankar, 'Industrial Engineering and Management', Galgotia Publications, **2003.**
2. J.G. Monks, 'Production/Operations Management', McGraw Hill, **2004.**
3. A.K. Chitale and R.C. Gupta, 'Product Design and Manufacturing', McGraw Hill, **2005.**
4. M. Sanders and E. McCormic, 'Human Factors in Engineering', McGraw Hill, **1993.**
5. R. Curie, 'Introduction to Work Study', McGraw Hill, **1992.**

PRODUCT DESIGN AND DEVELOPMENT

Subject Code: BMEE1-358 **L T P C** **Duration: 35 Hrs.**
3 0 0 3

UNIT-I

Introduction: Product design objectives, concept, terminology, principles, requirements of a good product design, product types and design considerations for engineering, product life cycle, product specification and range, safety, liability and warranty aspects, patents and copyrights.

UNIT-II

Product Development –Technical and Business Concerns: Technology forecasting and technology S-Curve (Technology Stage), mission statement and technical questioning, economic analysis of product, customer needs and satisfaction, customer population and market segmentation, customer needs-types and models, gathering customer needs information, analysis of gathered information.

UNIT-III

Designing for Specific Requirements: Design features and requirements with regard to manufacturing and assembly, safety, ergonomics, energy conservation, storage, transportation and maintenance, quality and reliability as a factor in product design, quality v/s cost, packaging design, role of national and international standards.

Visual Design: Objectives, form, function, material and process, relationship, product graphics, role of color.

Product Detailing: Need and objectives, considerations affecting detailing decisions, illustration of detailing.

UNIT-IV

Product Development: Concepts and objectives, information sources, role of innovation in product development and competitiveness, part approval process, advanced product quality planning, design failure mode and effect analysis, use of computers in product design and development, introduction to reverse engineering and rapid prototype development, the CAD-CAM link.

Learning Outcomes

The students will be able to:

1. Understand the basic product design objectives and requirements.
2. Understand the design principles for manufacturing
3. Understand the different design principles like designing for assembly, Maintenance, storage, transportation etc.
4. Understand the visual design with respect to form, function, material, Process, color etc.

Recommended Books

1. Neibel and Draper, ‘Product Design and Process’, McGraw Hill, New York, **2004.**
2. Mayal, ‘Industrial Design’, McGraw Hill, New York, **1999.**
3. Trott, ‘Innovation Management and New Product Development’, Pearson Education Asia, New Delhi, **2007.**
4. M. Asimov, ‘Fundamentals of Engineering Design’, PHI, New Delhi, **2000.**
5. Chitale and Gupta, ‘Product Design and Manufacturing’, PHI, New Delhi, **2007.**

STRENGTH OF MATERIALS-II

Subject Code: BMEE1- 410 **L T P C** **Duration: 46 Hrs.**
3 1 0 4

Learning Objectives and Outcomes: The course is designed to understand the concepts of strain
energy, resilience, stress under impact loading; shear stress distribution in a beam of various cross sections; stress in curved beams; stresses in helical, spiral, leaf and flat spiral springs; stress and strain analysis of thin, thick cylinder and spheres subjected to internal pressure; various theories of failure. The outcome of the course is to understand the stress analysis in various mechanical members e.g. thin and thick cylinders, rotating discs, curved beams and springs under various load conditions. The student will be able to properly analyze and design these mechanical members from the strength point of view.

UNIT-10 (Hrs.)

Strain Energy: Introduction to strain energy, energy of dilation and distortion. Resilience, stress due to suddenly applied and impact loading. Castigliano's theorem.

Theories of Failure: Maximum principal stress theory, maximum shear stress theory, maximum principal strain theory, total strain energy theory, shear strain energy theory. Graphical representation and derivation of equation for these theories and their application related to two dimensional stress systems.

UNIT-II (13 Hrs.)

Thin Cylinders and Spheres: Calculation of Hoop stress, longitudinal stress in a thin cylinder, effects of joints, change in diameter, length and internal volume. Principal stresses in sphere, change in diameter and internal volume.

Thick Cylinders: Derivation of Lame's equations, calculation of radial, longitudinal and hoop stresses and strains due to internal pressure in thick cylinders, compound cylinders, shrinkage allowance and shrinkage stress.

Rotational discs: Stresses in rotating discs and rims of uniform thickness; disc of uniform strength.

UNIT –III (11 Hrs.)

Bending of Curved Beams: Calculation of stresses in cranes or chain hooks, rings of circular and trapezoidal section and chain links with straight sides.

Shear Stresses in Beams: Shear stress distribution in rectangular, circular, triangular, I, T and channel section beams.

UNIT-IV (10 Hrs.)

Springs: Types of springs, derivation of strain energy (S.E.) equation, stress and S.E. in open and closed coiled helical springs under the action of axial load and/or couple. Bending stress, deflection and S.E. in Leaf spring, S.E. in flat spiral springs.

Recommended Books

1. Sadhu Singh, 'Strength of Materials', Khanna Publishers.
2. Kirpal Singh, 'Mechanics of Materials', Standard Publishers.
3. G.H. Ryder, 'Strength of Materials', Macmillan India Ltd.
4. S.S. Rattan, 'Strength of Materials', Tata McGraw Hills.
5. Timoshenko and Gere, 'Mechanics of Materials', CBS Publishers.
6. E.P. Popov, 'Mechanics of Materials', Pearson Education.
7. Beer and Johnsons, 'Strength of Materials', Macgraw Hills.

THEORY OF MACHINES – II

Subject Code: BMEE1-411 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Learning Objectives & Learning Outcomes: The students will understand the basic concepts of inertia forces & couples applied to reciprocating parts of a machine. Students should be able to understand balancing of masses and design of gears & gear trains. They will also gain knowledge of kinematic synthesis and different applications of gyroscopic effect.

UNIT-I (12 Hrs.)

Static Force Analysis: Concept of force and couple, free body diagram, condition of equilibrium, static equilibrium of mechanism, methods of static force analysis of simple mechanisms. Power transmission elements, considerations of frictional forces

Dynamic Force Analysis: Determination of forces and couples for a crank, inertia of reciprocating parts, dynamically equivalent system, analytical and graphical method, inertia force analysis of basic engine mechanism, torque required to overcome inertia and gravitational force of a four bar linkage.

UNIT-II (11 Hrs.)

Balancing: Necessity of balancing, static and dynamic balancing, balancing of single and multiple rotating masses, partial unbalanced primary force in an engine, balancing of reciprocating masses, and condition of balance in multi cylinder in line V-engines, concept of direct and reverse crank, balancing of machines, rotors, reversible rotors.

UNIT-III (11 Hrs.)

Gears: Toothed gears, types of toothed gears and its terminology. Path of contact, arc of contact, conditions for correct gearing, forms of teeth, involutes and its variants, interference and methods of its removal. Calculation of minimum number of teeth on pinion/wheel for in volute rack, helical, spiral, bevel and worm gears Center distance for spiral gears and efficiency of spiral gears

Gear Trains: Types of gear trains, simple, compound and epicyclic gear trains, problems involving their applications, estimation of velocity ratio of worm and worm wheel.

UNIT-IV (11 Hrs.)

Gyroscopic Motion and Couples: Effect on supporting and holding structures of machines. Stabilization of ships and planes, gyroscopic effect on two and four wheeled vehicles and stone crusher, Lower and higher Pairs: Universal Joint, Calculation of maximum Torque, Steering Mechanisms including Ackerman and Davis approximate steering mechanism,

Recommended Books

1. S.S. Rattan, ‘Theory of Machines’, Tata McGraw Hill.
2. John, Gordon, and Joseph, ‘Theory of Machines and Mechanisms’, Oxford University Press.
3. Hams Crone and Roggers, ‘Theory of Machines’.
4. Shigley, ‘Theory of Machines’, McGraw Hill.
5. V.P. Singh, Theory of Machines, Dhanpat Rai and Sons.

FLUID MECHANICS-I

Subject Code: BMME1-412 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Learning Objectives

1. To understand the behavior of fluids at rest and in motion.
2. To understand effects of the fluids on the boundaries of various cross sectional elements.
3. To understand analytical abilities related to fluid flow.
4. To conceptual understanding of fluids and their properties.
5. To understand the concept of modeling, prototype and simulation of fluid elements.

UNIT-I (12 Hrs.)

Fluid and their properties: Concept of fluid; ideal and real fluids; capillarity, vapour pressure, surface tension, viscosity, compressibility and bulk modulus; Newtonian and non- Newtonian fluids.

Fluid Statics: Concept of pressure, Pascal's law and its engineering applications, Hydrostatic paradox. Action of fluid pressure on a plane (horizontal, vertical and inclined) submerged surface, resultant force and center of pressure, force on a curved surface due to hydrostatic pressure. Buoyancy and flotation, stability of floating and submerged bodies, metacentric height and its determination, periodic time of oscillation.

UNIT-II (11 Hrs.)

Fluid Kinematics: Classification of fluid flows, velocity and acceleration of fluid particle, local and convective acceleration, normal and tangential acceleration, streamline, path line and streak line, stream and velocity potential functions, continuity equation in Cartesian and cylindrical coordinates. Rotational flows, rotation velocity and circulation and flow net.

Fluid Dynamics: Euler's equation, Bernoulli's equation and steady flow energy equation; representation of energy changes in fluid system, impulse momentum equation, kinetic energy and momentum correction factors.

UNIT-III (11 Hrs.)

Dimensional Analysis and Similitude: Fundamental and derived units and dimensions, dimensional homogeneity. Rayleigh's and Buckingham's Pi method for dimensional analysis. Dimensionless numbers and their significance, geometric, kinematic and dynamic similarity, model studies.

UNIT-IV (11 Hrs.)

Laminar and Turbulent Flows: Flow regimes and Reylods number, critical velocity and critical Reynolds number, laminar flow in circular cross- section pipes.

Turbulent flows and flow losses in pipes, Darcy equation, chezy's formula, minor head losses in pipes and pipe fittings, hydraulic and energy gradient lines.

Flow Measurement: Manometers, rotameter, pitot tubes, venturimeter, orifice meters, mouthpieces, notches and weirs.

Recommended Books

1. D.S. Kumar, 'Fluid Mechanics and Fluid Power Engineering', S.K. Kataria and Sons. Publishers.
2. B.S. Massey, 'Mechanics of Fluids', Van Nostrand Reinhold Co.
3. V.L. Streets and E.B. Wylie, 'Fluid Mechanics', McGraw Hill Book Co.

APPLIED THERMODYNAMICS – II

Subject Code: BMEE1- 413 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Unit –I

Air Compressors- Introduction: Classification of Air Compressors; Application of compressors and use of compressed air in industry and other places; Complete representation of compression process on P-v and T-s coordinates with detailed description of areas representing total work done and polytropic work done; Areas representing ***energy lost*** in internal friction, *energy carried away by cooling water* and ***additional flow work*** being done for un-cooled and cooled compression on T-S coordinates; Best value of index of compression; Isentropic, polytropic and isothermal efficiencies and their representation in terms of ratio of areas representing various energy transfers on T-s coordinates.

Reciprocating Air Compressors

Single stage single acting reciprocating compressor (with and without clearance volume): construction, operation, work input and best value of index of compression, heat rejected to cooling medium, isothermal, overall thermal, isentropic, polytropic, mechanical efficiency, **Clearance Volumetric efficiency**, Overall volumetric efficiency, effect of various parameters on volumetric efficiency, free air delivery; Multistage compressors: purpose and advantages, construction and operation, work input, heat rejected in intercoolers, minimum work input, optimum pressure ratio; ***isothermal***, ***overall thermal***, ***isentropic***, ***polytropic*** and ***mechanical*** efficiencies; Performance curves.

Unit –II

Positive Displacement Rotary Compressors Introduction: Comparison of rotary positive displacement compressors with reciprocating compressors; Classification of rotary compressors; Construction, operation, work input and efficiency of positive displacement type of rotary compressors like Roots blower, Lysholm compressor and Vane Type Blower.

Thermodynamics of Dynamic Rotary Compressors: Applications of Steady Flow Energy Equation and thermodynamics of dynamic (i.e., *centrifugal* and *axial flow m/cs*) compressors; Stagnation and static values of pressure, Temperature and enthalpy etc. for flow through dynamic rotary machines; Complete representation of compression process on T-S coordinates with detailed description of areas representing total work done, polytropic work done; ideal work required for compression process, areas representing energy lost in internal friction, energy carried away by cooling water on TS coordinates for an uncooled and cooled compression; ***isentropic***, ***polytropic***, and ***isothermal efficiencies*** as ratios of the areas representing various energy transfers on T-S coordinates.

Unit –III

Centrifugal Compressors: Complete thermodynamic analysis of centrifugal compressor stage; Polytropic, isentropic and isothermal efficiencies; Complete representation of compression process in the centrifugal compressor starting from ambient air flow through the suction pipe, Impeller, Diffuser and finally to delivery pipe on T-S coordinates; Pre-guide vanes and pre-whirl; Slip factor; Power input factor; Various modes of energy transfer in the impeller and diffuser; Degree of Reaction and its derivation; Energy transfer in backward, forward and radial vanes; Pressure coefficient as a function of slip factor; Efficiency and out-coming velocity profile from the impeller; Derivation of non-dimensional parameters for plotting compressor

characteristics; Centrifugal compressor characteristic curves; Surging and choking in centrifugal compressors.

Axial Flow Compressors

Different components of axial flow compressor and their arrangement; Discussion on flow passages and simple theory of aerofoil blading; Angle of attack; coefficients of lift and drag; Turbine versus compressor blades; Velocity vector; Vector diagrams; Thermodynamic analysis; Work done on the compressor and power calculations; Modes of energy transfer in rotor and stator blade flow passages; Detailed discussion on work done factor, degree of reaction, blade efficiency and their derivations; ***Isentropic***, ***polytropic*** and ***isothermal efficiencies***; Surging, Choking and Stalling in axial flow compressors; Characteristic curves for axial flow compressor; flow parameters of axial flow compressor like Pressure Coefficient, Flow Coefficient, Work Coefficient, Temperature-rise Coefficient and Specific Speed; Comparison of axial flow compressor with centrifugal compressor and reaction turbine; Field of application of axial flow compressors.

Unit –IV

Gas Turbines Classification and comparison of the Open and Closed cycles; Classification on the basis of combustion (at ***constant volume*** or ***constant pressure***); Comparison of gas turbine with a steam turbine and IC engine; Fields of application of gas turbines; Position of gas turbine in power industry; Thermodynamics of constant pressure gas turbine cycle (Brayton cycle); Calculation of net output, work ratio and thermal efficiency of ideal and actual cycles; Cycle air rate, temperature ratio; Effect of changes in specific heat and that of mass of fuel on power and efficiency; Operating variables and their effects on thermal efficiency and work ratio; Thermal refinements like regeneration, inter-cooling and re-heating and their different combinations in the gas turbine cycle and their effects on gas turbine cycle i.e. gas turbine cycle. Multistage compression and expansion; Blade materials and selection criteria for these materials and requirements of blade materials.

Jet Propulsion Principle of jet propulsion; Speed of sound and Mach Number, Description of different types of jet propulsion systems like rockets and thermal jet engines, like **(i) Athodyds** (ramjet and pulsejet), **(ii)** Turbojet engine, and **(iii)** Turboprop engine. Thermodynamics of turbojet engine components; Development of thrust and methods for its boosting/augmentation; Thrust work and thrust power; Propulsion energy, Propulsion and thermal (internal) efficiencies; Overall thermal efficiency; Specific fuel consumption**;** Rocket propulsion, its thrust and thrust power; Propulsion and overall thermal efficiency; Advantages and disadvantages of jet propulsion over other propulsion systems; Brief introduction to performance characteristics of different propulsion systems; Fields of application of various propulsion units.

Recommended Books:

1. R. Yadav, Sanjay and Rajay, ‘Applied Thermodynamics’, Central Publishing House.
2. J.S. Rajadurai, ‘Thermodynamics and Thermal Engineering’, New Age International (P) Ltd. Publishers.
3. D.S. Kumar and V.P. Vasandani, ‘Heat Engineering’, Metropolitan Book Co. Pvt. Ltd.
4. K. Soman, ‘Thermal Engineering’, PHI Learning Pvt. Ltd.
5. G. Rogers and Y. Mayhew, ‘Engineering Thermodynamics’, Pearson.
6. D.G. Shephered, ‘Principles of Turbo Machinery’, Macmillan.
7. H. Cohen, G.F.C. Rogers and M. Sarvan, ‘Gas Turbine Theory’, Longmans.

MATERIALS SCIENCE & METALLURGY

Subject Code: BMEE1-414 **L T P C** **Duration: 36 Hrs.**
3 0 0 3

Learning Objectives

1. To understand the fundamental concepts of crystallography, phase transformation and heat treatment processes.
2. To understand the atomic structure of metals, imperfections, diffusion mechanisms and theories of plastic deformation.
3. To understand equilibrium diagrams, time-temperature transformation curves and heat treatment processes.
4. To understand the phase diagrams which are useful for design and control of heat treating processes.

Learning Outcomes:

CO1: To develop fundamental concepts of crystallography, atomic structure imperfections.
CO2: The students will learn phase transformations, the theories of plastic deformation of metals and diffusion mechanisms
CO3: They will understand equilibrium diagrams, time-temperature transformation curves for design and control of heat treating processes.
CO4: Upon completion of the course, the students will be able to understand the interpretations of microstructure of metals and heat treatment processes.
CO5: Student understands composition of alloys and effect of alloying elements on the structures and properties of steel. Student will also able to classify ferrous metals and their alloys.

UNIT-I (12 Hrs.)

Crystallography: Atomic structure of metals, atomic bonding in solids, crystal structures, crystal lattice of body centered cubic, face centered cubic, closed packed hexagonal; crystalline and non-crystalline materials; crystallographic notation of atomic planes; polymorphism and allotropy; imperfection in solids: theoretical yield strength, point defects, line defects and dislocations, interfacial defects, bulk or volume defects. Diffusion: diffusion mechanisms, steady-state and non-steady -state diffusion, factors affecting diffusion. Theories of plastic deformation, recovery, re-crystallization.

UNIT-II (11 Hrs.)

Phase Transformation: General principles of phase transformation in alloys, phase rule and equilibrium diagrams, Equilibrium diagrams of Binary systems. Iron carbon equilibrium diagram and various phase transformations. Time temperature transformation curves (TTT curves): fundamentals, construction and applications.

UNIT-III (12 Hrs.)

Heat Treatment: Principles and applications. Processes viz. annealing, normalizing, hardening, tempering. Surface hardening of steels: Principles of induction and oxyacetylene flame hardening. Procedure for carburising, nitriding and cyaniding. Harden-ability: determination of harden-ability. Jominy end-quench test. Defects due to heat treatment and their remedies; effects produced by alloying elements. Composition of alloy steels.

Unit –IV (10 Hrs.)

Ferrous Metals and their Alloys: Introduction, classification, composition of alloys, effect of alloying elements (Si, Mn, Ni, Cr, Mo, W, Al) on the structures and properties of steel.

Recommended Books

1. Y. Lakhin, 'Engineering Physical Metallurgy', Mir Publishers.
2. Sidney H. Avner, 'Introduction to Physical Metallurgy, Tata McGraw Hill.
3. V. Raghavan, Physical Metallurgy: Principles and Practice, PHI Learning.
4. T. Goel and R.S. Walia, 'Engineering Materials & Metallurgy'.
5. B. Zakharov, 'Heat Treatment of Metals', University Press.

FLUID MECHANICS-I LAB.

Subject Code- BMEE1-416 **L T P C**
0 0 2 1

1. To determine the metacentric height of a floating vessel under loaded and unloaded conditions.
2. To study the flow through a variable area duct and verify Bernoulli's energy equation.
3. To determine the coefficient of discharge for an obstruction flow meter (venturi meter/ orifice meter)
4. To determine the discharge coefficient for a V- notch and rectangular notch.
5. To study the transition from laminar to turbulent flow and to ascertain the lower critical Reynolds number.
6. To determine the hydraulic coefficients for flow through an orifice.
7. To determine the friction coefficients for pipes of different diameters.
8. To determine the head loss in a pipe line due to sudden expansion/ sudden contraction/ bend.

MATERIALS SCIENCE & METALLURGY LAB.

Subject Code: BMME1-418 **L T P C**
0 0 2 1

Learning Objectives

1. To understand the fundamental concepts of crystallography and heat treatment processes.
2. To recognize the specimen preparations for microstructure study of metals.
3. To appreciate equilibrium diagrams, time-temperature transformation curves.

Learning Contents

1. Preparation of models/charts related to atomic/crystal structure of metals.
2. Annealing the steel specimen and study the effect of annealing time and temperature on hardness of steel.
3. Hardening the steel specimen and study the effect of quenching medium on hardness of steel.
4. Practice of specimen preparation (cutting, mounting, polishing, etching) of mild steel, aluminium and hardened steel specimens.
5. Study of the microstructure of prepared specimens of mild steel, Aluminium and hardened steel.
6. Identification of ferrite and pearlite constituents in given specimen of mild steel.
7. Determination of hardenability of steel by Jominy End Quench Test.

COMPOSITE MATERIALS

Subject Code: BMEE1-459 **L T P C** **Duration: 35 Hrs.**
3 0 0 3

Learning Objectives: This subject introduces to the students the different types of composite materials, their properties and applications.

UNIT-I

Introduction to Composites: Fundamentals of composites - need for composites – Enhancement of properties - classification of composites – Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Reinforcement – Particle reinforced composites, Fibre reinforced composites. Applications of various types of composites.

UNIT-II

Polymer Matrix Composites: Polymer matrix resins – Thermosetting resins, thermoplastic resins – Reinforcement fibres – Rovings – Woven fabrics – Non woven random mats – various types of fibres. PMC processes - Hand lay-up processes – Spray up processes – Compression moulding – Reinforced reaction injection moulding - Resin transfer moulding – Pultrusion – Filament winding – Injection moulding. Fibre reinforced plastics (FRP), Glass fibre reinforced plastics

UNIT-III

Metal Matrix Composites: Characteristics of MMC, Various types of Metal matrix composites Alloy vs. MMC, Advantages of MMC, Limitations of MMC, Metal Matrix, Reinforcements – particles – fibres. Effect of reinforcement - Volume fraction – Rule of mixtures. Processing of MMC – Powder metallurgy process - diffusion bonding – stir casting – squeeze casting.

UNIT-IV

Ceramic Matrix Composites: Engineering ceramic materials – properties – advantages – limitations – Monolithic ceramics - Need for CMC – Ceramic matrix - Various types of Ceramic Matrix composites- oxide ceramics – non oxide ceramics – aluminium oxide – silicon nitride – reinforcements – particles- fibres- whiskers. Sintering - Hot pressing – Cold isostatic pressing (CIPing) – Hot isostatic pressing (HIPing).
ADVANCES IN COMPOSITES: Carbon / carbon composites – Advantages of carbon matrix – limitations of carbon matrix Carbon fibre – chemical vapour deposition of carbon on carbon fibre perform. Sol gel technique. Composites for aerospace applications.

Recommended Books

1. K.K. Chawla, 'Composite Materials, Springer – Verlag', **1987.**
2. S.C. Sharma, 'Composite Materials, Narosa Publications, **2000**.
3. A.B. Strong, 'Fundamentals of Composite Manufacturing, SME, **1989**.

WELDING TECHNOLOGY

Subject Code: BMEE1-460 **L T P C** **Duration: 35 Hrs.**
3 0 0 3

UNIT–I

Introduction: Basic classification of welding processes, weld thermal cycle, weld metallurgy, solidification mechanism and micro-structural products in weld metal, epitaxial, cellular and dendritic solidification, metallurgical changes in weld metal, properties of weld metal. Heat

affected zone, re-crystallization and grain growth of HAZ, effects of alloying elements on welding of ferrous metals.

Welding Arc: Arc characteristics, arc column, arc blow, electrical characteristics of an arc, types of welding arcs, mechanism of arc initiation and maintenance, role of electrode polarity on arc behavior and arc stability.

UNIT-II

Welding Processes

Manual Metal Arc Welding (MMAW): welding circuit, SMAW operation, striking & restriking, metal fusion and weld penetration, Electrode motions and applications of SMAW.

Submerged Arc Welding: Circuit & setup for SAW, SAW process and operation, process variables, SAW wires and SAW fluxes, applications of SAW.

GAS Metal Arc Welding: power source, wire feed units, Welding circuit and setup, GMAW variables GMAW operation & technique, applications of GMAW.

UNIT-III

Welding Power Sources: Requirements for an arc welding power source, constant current characteristics, duty cycles, operating principles of a welding transformer, requirements of welding transformer,

UNIT-IV

Solid State Welding Processes: Forge welding, Friction welding, diffusion welding Explosive welding, ultrasonic welding, Electron beam welding, Laser welding, allied processes- Soldering, Brazing, Adhesive bonding, surfacing and Thermal spraying.

Recommended Books

1. R.S. Parmar, 'Welding Processes & Technology', Khanna Publishers.
2. R.S. Parmar, 'Welding Engineering & Technology', Khanna Publishers.
3. S.V. Nandkarni, 'Modern Arc Welding Technology', Oxford & IDH Publishing Co.
4. Lancaster, 'The Physics of Welding', Pergaman Press.
5. Richard L. Little, 'Welding & Welding Technology', McGraw Hill.

MATERIAL MANAGEMENT

Subject Code: BMEE1-461 **L T P C** **Duration: 35 Hrs.**

3 0 0 3

UNIT-I

Introduction: Introduction to material management and productivity, functions of material management, organization structures in material management, role of material management techniques in improved material productivity.

Material Planning: objectives, material requirement planning, manufacturing resource planning, JIT production planning, strategic material planning, material control: acceptance, sampling, inspection, make or buy decision, simple cost analysis, economic analysis, break even analysis, breakeven point theory, whether to add or drop a product line store management and warehousing, product explosion

UNIT-II

Purchasing: Importance of good purchasing system, organization of purchasing functions, purchase policy and procedures, responsibility and limitations, purchasing decisions, purchasing role in new product development, role of purchasing in cost reduction, negotiations and purchase, purchasing research: identification of right sources of supply, vendor rating,

standardization, vendor certification plans, vendor and supply reliability, developing new source of supply.

UNIT-III

Cost Reduction: cost control v/s cost reduction, price analysis, material cost reduction techniques, variety reduction, cost reduction and value improvement, techniques of cost control, standard costing, cost effectiveness, cost analysis for material management, material flow cost control.

Unit-IV

Inventory Management: Inventory v/s stores, types of inventory, inventory control, inventory build –up, EOQ, various inventory models, inventory models with quantity discount, exchange curve concept, coverage analysis, optimal stocking and issuing policies, inventory management of perishable commodities, ABC – VED analysis, design of inventory distribution systems, surplus management, information system for inventory management, case studies.

Learning Outcomes (CO)

1. To expose the students to the different components and functions of material Management.
2. To Under Stand the Inventory controls procedure.
3. To Understand the Codification of materials.
4. To Understand Purchase policies and procedures.

Recommended Books

1.W.R. Stelzer, 'Material Management', Prentice Hall of India.
2. D.S. Ammer & Richard Erwin Inc., 'Material Management'.
3. A.K. Dutta, 'Material Management', Prentice Hall of India.
4. P. Gopal, A. Krishnan & M. Sundersen, 'Material Management', Prentice Hall of India.

DESIGN OF MACHINE ELEMENTS-I

Subject code: BMEE1-519 **L T P C** **Duration: 25 Hrs.**
2 0 0 2

Learning Objectives: To present the basic knowledge of design procedure for simple components like keys, cotters, fasteners, shafts, couplings, pipe joints and levers under static and fatigue loading. At the end of this course, the student should be able to develop mechanical systems consisting of wide range of machine elements. Basic design of different machine elements will be discussed

UNIT-I

Basic Design Considerations: Meaning of machine design, Empirical design, Rational design, Aesthetic design, Ergonomic design, design process, stress-concentration, endurance limit, fatigue and reliability considerations, factor of safety and its selection, basics of tolerance, basics of fits, Introduction to creep.

Material Selection and Material Properties: Designation of materials according to Indian standards code, Selection of material, mechanical properties of materials.

UNIT-II

Analysis and Design of Fasteners

a) Riveted joints-boiler joints, structural joints, lozenge joints, eccentrically loaded joints.
b) Welded joints in torsion, shear and direct loads, eccentrically loaded joints.
c) Bolts and bolted joints with and without initial tightening loads, Bolted joints under eccentric loading.

Design of Cottered Joints
a) Design of spigot and socket cotter joint,
b) Design of Gib and cotter joint
c) Design of knuckle joint.

UNIT-III

Design of Shaft: Design of solid and hollow shafts for transmission of torque, Shafts subject to pure torsion, pure bending and shafts under combined loading, design of shaft on the basis of rigidity.

Design of Couplings, Keys and Splines: a) Rigid Coupling: design of sleeve, split muff coupling and Flanged coupling. b) Flexible coupling: design of pin type flexible coupling and Universal joint. Type of keys, Design of keys based on shear and crushing failures, Advantages of splines and their design.

UNIT-IV

Design of Pipe Joints: Type of joints, Design of Circular, oval and square flanged pipe joints.

Design of levers: Levers of type I, II and III, Mechanical advantage, leverage, Design of levers (foot lever, hand lever, cranked lever, bell crank lever, safety valve lever and shoe brake lever).

Learning Outcomes: The students will be able to:

1. Understand the basic of machine design, process and requirements for design of machine elements.
2. Select the suitable materials.
3. Design simple components like fasteners, shafts, keys, couplings, pipe joints, levers etc.

Recommended Books

1. V.B. Bhandari, 'Design of Machine Elements', Tata McGraw Hill, New Delhi, **2007.**
2. J. Shigley, 'Mechanical Engineering Design', McGraw Hill Book Company Inc., New York, **2003.**
3. M.F. Spotts and T.E. Shoup, 'Design of Machine Elements', Pearson Education, New Delhi, **2003**.
4. R.L. Norton, 'Machine Design: An Integrated Approach', Pearson Education, New Delhi, **2006.**
5. C.S. Sharma and K. Purohit, 'Design of Machine Elements', Prentice Hall, New Delhi, **2003.**

Note: 1. Design data book is not allowed.

MECHANCIAL MEASUREMENTS AND METROLOGY

Subject code: BMEE1-520 **L T P C** **Duration: 35 Hrs.**
3 0 0 3

UNIT-I

Introduction: Definition, Significance, modes and applications of measurement systems, Instrument classification, generalized measurement system and its functional elements, Input-output configuration of measuring instruments, Methods of correction for interfering & modifying inputs, Standards, Calibration, Introduction to Static characteristics and Dynamic characteristics, Selection of instruments, Loading effects.

UNIT-II

Errors in Measurement: Sources of errors; Gross, Systematic and Random errors; Statistical analysis of test data- single sample test and multi sample test; Probable error –average and standard deviation for normal curves; Rejection of test data.

Metrology: Line; end and wavelength standards. Linear measurements; comparators - their types; relative merits and limitations. Angular measurements - sine bar; clinometers; angle gauge. Concept and measurement of straightness and flatness by interferometry. Surface 14 roughness - specifications and measurement. Measurement of major diameter; minor diameter; effective diameter; pitch; angle and form of threads for internal and external threads. Measurement of tooth thickness; pitch and checking of profile for spur gears.

UNIT-III

Functional Elements: Introduction to sensors and transducers; types of sensors; review of electro-mechanical sensors and transducers - variable resistance; inductance and capacitive pickups; photo cells and piezoelectric transducers and application of these elements for measurement of position/displacement; speed / velocity / acceleration; force and liquid level. Resistance strain gauges; gauge factor; bonded and unbounded gauges; temperature compensation; application of strain gauges for direct; bending and torsional loads. Introduction to amplifying transmitting and recording devices.

Pressure and Flow Measurement: Bourdon tube; diaphragm and bellows; Vacuum measurement –McLeod gauge; thermal conductivity gauge and ionization gauge; dead weight gauge tester. Electromagnetic flux meters; ultra-sonic flow meters and hot wire anemometer. Flow visualization techniques.

UNIT-IV

Temperature Measurement: Thermal expansion methods - bimetallic thermometers; liquid-in-glass thermometer and filled-in-system thermometers; thermo-electric sensors - common thermocouples; reference junction considerations; special materials and configurations; metal resistance thermometers and thermistor; optical; total radiation pyrometers; calibration standards.

Speed; Force; Torque and Shaft Power Measurement: Mechanical tachometers; vibration reed tachometer and stroboscope; proving ring; hydraulic and pneumatic load cells; torque on rotating shafts; Absorption; transmission and driving dynamometers.

Learning Outcomes

After studying this course, students shall be able to:

1. Understand the classification of measurements and measurement standards used in industrial applications
2. Understand about various errors in measuring systems and evaluate the errors by statistical methods.
3. Know about functions and types of sensors and transducers and their utility in instrumentation.
4. Use various instruments for measurements like pressure, flow, temperature etc. in manufacturing or process industry.

Recommended Books

1. E.O. Doebelin, ‘Measurement System: Application and Design’, McGraw Hill, **2008**.
2. A. Bewoor and V. Kulkarni, ‘Metrology and Measurement’, McGraw-Hill, **2009.**
3. R.K. Rajput, ‘Mechanical Measurement and Instrumentations’, S.K. Kataria Publishers, **2012.**
4. Morris Alan S., ‘The Essence of Measurement’, Prentice Hall of India, **1996.**

AUTOMOBILE ENGINEERING

Subject Code: BMEE1-521 **L T P C** **Duration: 35 Hrs.**
3 0 0 3

UNIT-I

Introduction: Basic structure, general layout and type of automotive vehicles, Frameless and unitary construction; position of power unit; Components of the Automobile; Functions of Major Components of an Automobile

Power Unit: Power requirements - motion resistance and power loss, tractive effort and vehicle performance curves; selection of power unit and engine performance characteristics; pollution due to vehicle emission and exhaust emission control system, silencers, types of pistons and rings

Fuel Supply System: Air cleaner and fuel pumps; Air fuel requirements and carburation; constructional details of Carter carburetors and fuel injection systems; MPFi (Petrol), Diesel fuel system - cleaning, injection pump, injector and nozzles, Common Rail fuel supply system

UNIT-II

Lubrication and Cooling Systems: Necessity of lubrication; Desirable properties of lubricants; various types of lubricants and oil additives; different systems of lubrication - oil filters, oil pumps and oil pressure indicator; crank case ventilation and dilution. Purpose of cooling, air and water cooling systems; radiator, thermostat, pump and fan.

Chassis and Suspension: Loads on the frame, considerations of strength and stiffness, engine mounting, independent suspension systems (Mac Pherson, Trailing Links, Wishbone), shock absorbers and stabilizers; wheels and tyres, tyre wear types, constructional details of plies

UNIT-III

Transmission System: Basic requirements and standard transmission systems; constructional features of automobile clutch, gear box, differential, front and rear axles; overdrives, propeller shaft, universal joint and torque tube drive; Rear wheel vs front wheel drive, principle of automatic transmission

Steering System: Requirement and steering geometry; castor action, camber and king pin angle, toe-in of front wheels, steering linkages and steering gears; wheel alignment; power steering, Ball re-circulating mechanism

Braking System: General braking requirements; Mechanical, hydraulic, vacuum power and servo brakes; Weight transfer during braking and stopping distances, Anti-Braking systems.

UNIT-IV

Starting System: Principle, starting torque, engine resistance torque, and power required for starting of engine. Starter motor and its circuit. Types of drive mechanisms: Bendix drive, pinion type, axial sliding armature starter. Slipping and overrunning of clutches, automatic switches for starting, cold starting devices: Glow plug & choke.

Electric System: Classification, Introduction to Conventional and transistorized ignition systems; Charging, capacity ratings and battery testing; starter motor and drive arrangements: voltage and current regulation, wiring, fuse system, circuit breakers, Relays, Switches. Layout and Wiring diagram for 2, 3 and 4 wheeler vehicles, Buses and Commercial vehicles

Maintenance: Preventive maintenance, trouble shooting and rectification in different systems; engine tuning and servicing, major tools used for maintenance of automobiles

Learning Outcomes - The student will be made to learn

1. Identify the different parts of the automobile

2. The location and importance of each part
3. The functioning of the engine and its accessories, gear box, clutch, brakes, steering, axles and wheels
4. Suspension, frame, springs and other connections
5. Emissions, ignition, controls, electrical systems and ventilation
6. Develop a strong base for understanding future developments in the automobile industry

Recommended Books

1. Kamaraju Ramakrishna, 'Automobile Engineering', PHI Learning, New Delhi, **2012.**
2. Jain & Asthana, 'Automobile Engineering', Tata McGraw-Hill, New Delhi, **2002**.
3. W.H. Crouse, 'Automotive Mechanics', McGraw Hill.
4. J. Heitner, 'Automotive Mechanics', East West Press.
5. Kirpal Singh, 'Automobile Engineering', Vol. I and II, Standard Publishers.
6. J. Webster, 'Auto Mechanics', Glencoe Publishing Co.
7. P.S Gill, 'Automobile Engineering', S.K. Kataria.

INDUSTRIAL AUTOMATION AND ROBOTICS

Subject code: BMEE1-522 **L T P C** **Duration: 37 Hrs.**
3 0 0 3

UNIT-I

Introduction: Concept and scope of automation: Socio economic impacts of automation Types of Automation, Low Cost Automation

Fluid Power: Fluid power control elements, Standard graphical symbols, Fluid power generators Hydraulic and pneumatic Cylinders - construction, design and mounting; Hydraulic and pneumatic Valves for pressure, flow and direction control

UNIT-II

Basic Hydraulic and Pneumatic Circuits: Direct and Indirect Control of Single/Double Acting Cylinders Designing of logic circuits for a given time displacement diagram & sequence of operations, Hydraulic & Pneumatic Circuits using Time Delay Valve & Quick Exhaust Valve Memory Circuit & Speed Control of a Cylinder Trouble shooting and "Causes & Effects of Malfunctions" Basics of Control Chain Circuit Layouts Designation of specific Elements in a Circuit.

Fluidics: Boolean algebra Truth Tables Logic Gates Coanda effect.

UNIT-III

Electrical and Electronic Controls: Basics of Programmable logic controllers (PLC) Architecture & Components of PLC Ladder Logic Diagrams.

Transfer Devices and Feeders: Classification, Constructional details and Applications of Transfer Devices Vibratory bowl feeders Reciprocating Tube Centrifugal hopper feeders.

UNIT-IV

Robotics Introduction: Classification based on geometry, control and path movement, Robot Specifications, Robot Performance Parameters Robot Programming Machine Vision, Teach pendants Industrial Applications of Robots

Recommended Books

1. Anthony Esposito, 'Fluid Power with Applications', Pearson Publications.
2. S.R. Majumdar, 'Pneumatic Control', McGraw Hill Publications.
3. S.R. Deb, 'Robotic Technology and Flexible Automation', Tata McGraw Hill Publications.

4. Saeed B. Niku, 'Introduction to Robotics', Wiley India.
5. Ashitava Ghosal, 'Robotics', Oxford Publications.

DESIGN OF MACHINE ELEMENTS-I LAB.

Subject code: BMEE1-523 **L T P C**
0 0 2 1

1. Select a suitable product and identify the design process talking the controlling parameters
2. To select a suitable material for the rim of a car/Justify the existing material
3. Design a wall bracket (bolted or riveted) which is being used in real life by actual measurement of load and justify your findings
4. Find a suitable flange coupling and justify its design by actual measurements
5. Design a shaft which is under torsion, bending and combined loading
6. Select a suitable lever setup and justify the design parameters
7. Design a Flanged pipe joint for any practical application.
8. Identify a square or rectangular key and design the same based on shearing and crushing

AUTOMOBILE ENGINEERING LAB.

Subject Code: BMEE1-525 **L T P C**
0 0 2 1

Study and demonstration of Layout of an Automobile
1. Trouble shooting in cooling system of an automotive vehicle
2. Trouble shooting in the ignition system, setting of contact breaker points and spark plug gap
3. Demonstration of steering system and measurement of steering geometry angles and their impact on vehicle performance.
4. Trouble shooting in braking system with specific reference to master cylinder, brake shoes, overhauling of system and the adjusting of the system and its testing.
5. Fault diagnosis in transmission system including clutches, gear box assembly and differential.
6. Disassembling of engine: inspection of engine components, servicing of components, measurement of dimensions of different components of engine, compare with standard specifications, piston ring setting, assembling using special tools.

FLUID MECHANICS-II

Subject code: BMEE1-562 **L T P C** **Duration: 37 Hrs.**
3 0 0 3

UNIT-I

Potential Flow: Stream function and velocity potential functions for standard flow patterns uniforms flow, source/sink, doublet and free vortex; combination of uniform flow with certain flows to obtain flow patterns of various shapes such as flow past a half body, a cylinder, a Rankine oval body, and a cylinder with circulation: Kutta joukowski Theorem-lift on a cylinder.
Viscous Flow: Navier Stokes equation of motion; Relationship between shear stress and pressure gradient; two dimensional laminar flow between two fixed parallel planes; Plain Couette flow and its application to hydro-dynamic theory of lubrication.

UNIT-II

Turbulence: Fluctuation velocity components; intensity and scale of turbulence; Reynolds equations and turbulence modeling.

Boundary Layer: Salient features of flow pattern in a boundary layer; Velocity and shear stress distribution along the boundary; Von-Karman momentum integral equation, Quantitative correlation for boundary layer thickness, local skin friction coefficient and drag coefficient in laminar, turbulent and laminar turbulent combined boundary layer flows on a flat plate without pressure gradient; flow over a curved surface boundary layer separation and its control.

UNIT-III

Flow around Immersed Bodies: Concept of friction, pressure, wave and induced drag- lift and drag coefficients; variation of drag coefficient with Reynolds number for two dimensional bodies (flat plate, circular cylinder); Vortex shedding from cylindrical bodies; effect of streamlining; drag coefficient versus Reynolds number for flow past axisymmetric bodies (sphere); Terminal velocity; Lift of an airfoil; Airfoil of finite length-effect on drag and lift; Downwash and induced drag.

UNIT-IV

Compressible Flow: Wave propagation and sonic velocity; Mach number, Limits of incompressibility and compressible flow regimes; pressure field due to a moving source of disturbance, Mach cone and Mach angle. Basic equations for one-dimensional compressible flow; static and stagnation values; Isentropic flow relations; compressibility correction factor. Isentropic flow through a duct of varying cross-section, mass flow rate and choking in a converging passage. Normal shock and change in flow properties across a normal shock wave.

Recommended Books

1. B.S. Massey, 'Mechanics of Fluids', ELBS and Van Nostrand Reinhold Co.
2. Pao H.F. Richard, 'Fluid Mechanics', John Wiley and Sons.
3. D.S. Kumar, 'Fluid Mechanics and Fluid Power Engineering', S.K. Kataria and Sons, Delhi.
4. J. F. Douglas, 'Fluid Mechanics', Gasionckw and Swaffield J.P. Pitman.
5. V.L. Streeter and E.B. Wylie, 'Fluid Mechanics', McGraw Hill International.

TOOL DESIGN

Subject Code: BMEE1-563 **L T P C** **Duration: 37 Hrs.**

3 0 0 3

UNIT-I

INTRODUCTION: General requirements to machine tools, Machine tool design recommendations, Classification of motions to shape surface, Machine tool drives for rectilinear motion, Periodic motion, reversing motion etc.

KINEMATICS OF MACHINE TOOLS: Kinematics or gearing diagram of Lathe, drilling machine, milling machine etc. Main drive and feed drive, principal specification of machine tools.

UNIT-II

DESIGN OF KINEMATICS SCHEME: Methods to determine transmission ratios for drives. Development of kinematics scheme, minimum of transmission, transmission groups, Determination of number of teeth on gears.

SPEED AND FEED BOXES: General requirement, Design of gear trains, types of speed boxes, speed changing devices, feed boxes, characteristics of feed mechanism, types of rapid traverse mechanisms, variable devices.

UNIT-III

SPINDLE DESIGN AND SPINDLE BEARINGS: Main requirements, Materials and details of spindle design, spindle bearings, bearings, types of bearing sand their selections, bearing materials.

BED, COLUMNS, TABLES AND WAYS: Materials, typical constructions and Design.

UNIT-IV

MACHINE TOOLS CONTROL SYSTEMS: Requirement of control system, selection and construction of control systems, Mechanical control system, predilection control, remote control safety devices.

MACHINE TOOL DYNAMICS: Dynamic performance, dynamic and elastic system of Machine, tools. Dynamics of cutting forces, tool chatter.

RECOMMENDED BOOKS:

1. Sen and Bhattacharya, 'Machine Tools Design', CBS Publishers.
2. N.K. Mehta, 'Machine Tool Design', Tata McGraw Hill.
3. N. Acherkan, 'Machine Tool Design', Four Volumes, Mir Publishers.
4. P.H. Joshi, 'Machine Tools Handbook: Design and Operation', McGraw Hill Professional'
5. S.K. Basu and D.K. Pal, 'Design of Machine Tools', Oxford and IBH.

FINITE ELEMENT METHODS

Subject Code: BMEE1-564 **L T P C** **Duration: 37 Hrs.**
3 0 0 3

UNIT – I

Introduction to Finite Element Method for solving field problems. Stress and Equilibrium. Strain -Displacement relations. Stress - strain relations.

UNIT – II

One Dimensional Problems: Finite element modeling coordinates and shape functions. Potential Energy approach: Assembly of Global stiffness matrix and load vector. Finite element equations, Treatment of boundary conditions, Quadratic shape functions.

UNIT – III

Analysis of Beams: Element stiffness matrix for two node, two degrees of freedom per node beam element.

Finite element modelling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions.

Finite element modelling of Axisymmetric solids subjected to Axisymmetric loading with triangular elements.

UNIT – IV

Two dimensional four noded isoparametric elements and numerical integration.

Steady state heat transfer analysis: one dimensional analysis of a fin and two dimensional analysis of thin plate. Analysis of a uniform shaft subjected to torsion.

Dynamic Analysis : Formulation of finite element model, element matrices, evaluation of Eigen values and Eigen vectors for a stepped bar and a beam.

Recommended Books

1. Chandraputla Ashok and Belegundu, 'Introduction to Finite Elements in Engineering', Prentice -Hall.
2. S.S. Rao, 'The Finite Element Methods in Engineering', Pergamon.
3. J.N. Reddy, 'An Introduction to Finite Element Method', McGraw Hill.
4. Alavala, 'Finite Element Methods', TMH.
5. Kenneth H. Huebner, Donald L. Dewhirst, Douglas E. Smith and Ted G. Byrom, 'The Finite Element Method for Engineers', John Wiley & Sons. (ASIA) Pte Ltd.
6. C.S. Krishna Murthy, 'Finite Element Analysis'.

DEIGN OF MACHINE ELEMENTS-II

Subject code: BMEE1-628 **L T P C** **Duration: 25 Hrs.**
2 0 0 2

Course Objectives: To expose the students to the design and analysis of different gears, brakes, clutches, belts, chain, ropes, bearings and springs. Basics of FEM and integration of computers in design of different machine elements will be discussed.

UNIT-I

Transmission Drives: Belt and rope drives: Belt drives and its selection, Design of Flat belt, V-belt and steel rope, Design of the pulley.
Chain Drives: Types of chains, polygonal effect, power rating, selection of bush roller chain.
Gear Drives: Type of gears, Terminology, Tooth profile, gear tooth failure, strength of gear tooth, Design of spur, helical, straight bevel gears, worm and worm wheel

UNIT-II

Clutches and Brakes: Introduction, types, construction, Design of band brakes, block brakes, internal and external expanding shoe brakes. Design of friction clutches (single plate, multi plate and cone), centrifugal clutches.
Design of Flywheel: Introduction, Energy stored in a flywheel, stresses in a rim/arms, design considerations.

UNIT-III

Bearings: Selection of bearings
Sliding and Rolling contact bearings*:* Principle of hydrodynamic/hydrostatic lubrication, bearing performance parameters, Design of journal bearings. Rating life, Average life, Selection of ball bearings and roller bearings.
Computer aided Machine Design and Introduction to FEM: Philosophy of Computer Aided Machine Design, Interactive design software, Basic advantages of analysis Software, Design of machine components through interactive programming. Introduction of the FEM, historical background, Brief overview of the steps used in FEM.

UNIT-IV

Close-coiled Helical springs: Introduction to types and applications, spring materials, compression and extension helical closed coil springs, Design of helical springs for round wires.
Leaf Springs: Construction, Nipping, pre stressing of springs, Design of semi elliptical leaf springs
Learning Outcomes: The students will be able to:
1. Do the force analyses on different gear types i.e., spur helical, bevel and worm?
2. Do the force analysis of block brake; analysis and design of band brake, internal expanding

3. brake, external expanding brake.
4. Design a single, multiple and cone clutch, flat, V-belts, chains and ropes.
5. Understand the sliding and rolling contact bearing.
6. Analyze and design the closed coiled helical spring and leaf spring.
7. Understand the role of computers in design

Recommended Books

1. V.B. Bhandari, 'Design of Machine Elements', Tata McGraw Hill, New Delhi, **2007.**
2. J. Shigley, 'Mechanical Engineering Design', McGraw Hill Book Company Inc., New York **2003**
3. M.F. Spotts and T.E. Shoup, 'Design of Machine Elements', Pearson Education, New Delhi, **2003.**
4. R.C. Juvinall and K.M. Marshek, 'Fundamental of Machine Component Design', John Wiley & Sons, New York**, 2005.**
5. R.L. Norton, 'Machine Design: An Integrated Approach', Pearson Education, New Delhi, **2006.**

Note: 1. Only the design data book compiled by PSG college of Engg. & Tech., Coimbatore and Machine Design data book by Balveera Reddy published by CBS publishers is allowed in Examination.

HEAT TRANSFER

Subject Code: BMEE1-629 **L T P C** **Duration: 40 Hrs.**
3 1 0 4

UNIT-I

Introduction: Concept of heat transfer, Difference between the subject of "Heat Transfer" and its parent subject "Thermodynamics". Different modes of heat transfer - conditions, convection, and radiation.

UNIT-II

Conduction: Fourier's law of heat conduction, coefficient of thermal conductivity, effect of temperature and pressure on thermal conductivity of solids, liquids and gases and its measurement. Three dimensional general conduction equation in rectangular, cylindrical and spherical coordinates involving internal heat generation and unsteady state conditions. Derivation of equations for simple one dimensional steady state heat conduction from three dimensional equations for heat conduction though walls, cylinders (Hollow and solid) and spherical shells (hollow and solid) (simple and composite), logarithmic mean area, Critical thickness of insulation, electrical analogy of the heat transfer phenomenon in the cases discussed above. Influence of variable thermal conductivity on conduction through simple cases of walls / cylinders and spheres. Equivalent areas, shape factor, conduction through edges and corners of walls and critical thickness of insulation layers on electric wires and pipes carrying hot fluids. Internal generation cases along with some practical cases of heat conduction like heat transfer through piston crown, dielectric heating, through under-ground electrical cables/Hot fluid pipes etc. and case of nuclear fuel rod with and without cladding. Overall heat transfer coefficient, Thermal contact resistance Introduction to unsteady heat transfer, lumped parameter analysis, time constant and response of a thermocouple, Newtonian heating and cooling of solids; definition and explanation of the term thermal diffusivity. Numerical.

Theory of Fins: Concept of fin, classification of fins and their applications. Straight fins of uniform cross-section; e.g. of circular, rectangular or any other cross-section). Straight fins with varying cross-sectional area and having triangular or trapezoidal profile area. Circumferential fins of rectangular cross section provided on the circumference of a cylinder. Boundary conditions of the fins and the cases arising therein. Fin performance: fin effectiveness and fin efficiency, total fin effectiveness, total fin efficiency. Optimum design of straight fin of rectangular and triangular profile area. Application of fins in temperature measurement of flow through pipes and determination of error in its measurement. Heat transfer from a bar connected to the two different temperature heat sources. Numericals.

UNIT-III

Convection: Introduction to hydrodynamics, Free and forced convection. Derivation of three-dimensional mass, momentum and energy conservation equations (with introduction to Tensor notations) Boundary layer formation, laminar and turbulent boundary layers (simple explanation only and no derivation). Thermal boundary layer over a flat plate. Theory of dimensional analysis and its application to free and forced convective heat transfer. Analytical formulae for heat transfer in laminar and turbulent flow over vertical and horizontal tubes and plates. Flow across a bank of tubes. Combined free and forced convection. Numerical.

Newton's law of cooling. Overall coefficient of heat transfer. Classification of heat exchangers, Different design criterion for heat exchangers. Log mean temperature difference for evaporator and condenser tubes, and parallel and counter flow heat exchangers, Calculation of number and length of tubes in a heat exchanger effectiveness and number of transfer units (NTU); fouling factor. Numericals.

Convection with Phase Change (Boiling and Condensation): Pool boiling, forced convection boiling, heat transfer during pool boiling of a liquid. Nucleation and different theories of nucleation, different theories accounting for the increased values of h.t.c. during nucleate phase of boiling of liquids; different phases of flow boiling (theory only), Condensation, types of condensation, film wise condensation on a vertical and inclined surface; on and inside horizontal tubes. Numerical.

UNIT-IV

Radiation: Process of heat flow due to radiation, surface emission properties, definition of emissivity, absorptivity, reflectivity and transmissivity. Concept of black and grey bodies, Plank's law of monochromatic radiation. Kirchhoff's law, Stefan Boltzmann's law and Wien's displacement law. Interchange factor. Intensity of radiation and Lambert's Cosine law.

Radiation Exchange between Surfaces: Reciprocity Theorem, Shape factor algebra and its features. Intensity of Radiation (Definition only), radiation density, irradiation, radiosity and radiation shields. Derivation formula for radiation exchange between two bodies using the definition of radiosity and irradiation and its application to cases of radiation exchange between three or four grey and black bodies and for two grey and black surfaces connected by single refractory surface (e.g. boiler or other furnaces), simplification of the formula for its application to simple bodies like two parallel surfaces, concentric cylinders and a body enveloped by another body etc. Coefficient of radiant heat transfer, Radiation from gases, vapors and flames. Error in Temperature measurement by a thermocouple probe due to radiation losses.

Recommended Books

1. Frank P. Incropera and David P. De Witt, 'Fundamentals of Heat and Mass Transfer', John Wiley.
2. P.S. Ghoshdastidar, 'Heat Transfer', Oxford Press.

3. D.S. Kumar, 'Fundamentals of Heat and Mass Transfer', S.K. Kataria & Sons.
4. A.J. Chapman, 'Heat Transfer', McGraw Hill Book Company, New York.
5. J.P. Holman, 'Heat Transfer', Tata McGraw-Hill Publishing Company Ltd.
6. A. Yunus Cengel, 'Heat and Mass Transfer', Tata McGraw Hills Education Private Ltd.

FLUID MACHINERY

Subject code: BMEE1-630 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

Learning Objectives: To expose the students to the basic fundamentals of Momentum Equation, Euler's equation for energy transfer, Impact of jets, turbines and pumps.

UNIT-I (12 Hrs.)

General Concepts: Impulse momentum principle; jet impingement on stationary and moving flat plates, and on stationary or moving vanes with jet striking at the center and tangentially at one end of the vane; calculations for force exerted, work done and efficiency of jet.

Basic components of a turbo machine and its classification on the basis of purpose, fluid dynamic action, operating principle, geometrical features, path followed by the fluid and the type of fluid etc. Euler's equation for energy transfer in a turbo machine and specifying the energy transfer in terms of fluid and rotor kinetic energy changes.

Viscous Flow: Momentum Equation, Navier Stokes Equation and its derivation, aerofoil theory, lift and drag.

UNIT-II (11 Hrs.)

Pelton Turbine: Component parts and operation; velocity triangles for different runners, work output; Effective head, available power and efficiency; design aspects such as mean diameter of wheel, jet ratio, number of jets, number of buckets with working proportions

Francis and Kaplan Turbines: Component parts and operation velocity triangles and work output; working proportions and design parameters for the runner; Degree of reaction; Draft tubes - its function and types. Function and brief description of commonly used surge tanks, Electro- Mechanical governing of turbines

UNIT-III (12 Hrs.)

Centrifugal Pumps: Layout and installation; Main elements and their functions; Various types and classification; Pressure changes in a pump - suction, delivery and manometric heads; vane shape and its effect on head-capacity relationships; Departure from Euler's theory and losses; pump output and efficiency; Minimum starting speed and impeller diameters at the inner and outer periphery; Priming and priming devices, Multistage pumps - series and parallel arrangement; submersible pumps. Construction and operation; Axial and mixed flow pumps; Trouble shooting - field problems, causes and remedies.

Similarity Relations and Performance Characteristics: Unit quantities, specific speed and model relationships, scale effect; cavitation and Thomas cavitation number; Concept of Net Positive Suction Head (NPSH) and its application in determining turbine / pump setting

UNIT-IV (10 Hrs.)

Reciprocating Pumps: Components parts and working; pressure variations due to piston acceleration; acceleration effects in suction and delivery pipes; work done against friction; maximum permissible vacuum during suction stroke; Air vessels.

Hydraulic Devices and Systems: Construction, operation and utility of simple and differential accumulator, intensifier, fluid coupling and torque converter, Air lift and jet pumps; gear, vane and piston pumps, Hydraulic Rams.

Learning Outcomes (CLO)

The students will be able to:

1. Understand the working principle of the hydropower plant, selection of design parameters, size calculations of the hydro turbine component.
2. Understand the governing, similarity relations and unit quantities for pump and turbine.
3. Understand the basic working principle of pumps, centrifugal and reciprocating pumps, their design parameters.

Recommended Books

1. R.L. Daughaty, Hydraulic Turbines, McGraw Hill.
2. Jagdish Lal, 'Hydraulic Machines', Metropolitan Book Co.
3. D.S. Kumar, 'Fluid Mechanics and Fluid Power Engineering', S.K. Kataria and Sons.
4. K. Subramaniam, 'Hydraulic Machines', Tata McGraw Hill.
5. S.S. Rattan, 'Fluid Machines and Hydraulic Machines', Khanna Publishers, New Delhi, **2004**.
6. J.F. Douglas, J.M. Gasiorek and J.A. Swaffield, 'Fluid Mechanics', Addison-Wesley. Longman Inc., Edinburgh, U.K., **1995.**
7. R.L. Panton, 'Incompressible Fluid Flow', John Wiley & Sons, New Jersey, **2005.**
8. F.M. White, 'Viscous Fluid Flow', McGraw Hill, New York, **2006.**
9. T. Wright, 'Fluid Machinery', CRC Press, USA, **2009.**

DESIGN OF MACHINE ELEMENTS -II LAB.

Subject Code: BMEE1-631 **L T P C**
0 0 2 1

1. Find an assembly containing the belt and pulley mechanism for a flat belt and do the complete design calculations and then justify the existing design.
2. Find an assembly containing the belt and pulley mechanism for a V belt and do the complete design calculations and then justify the existing design.
3. Locate a design a rope assembly for practical applications like cranes, recovery vans etc., and do the complete design calculations and then justify the existing design.
4. Find a transmission system involving the spur/helical gear and then find out the inputs required for its design and justify the design for the gear.
5. For a punching machine/ automobile/IC engines etc., study the flywheel location and suggest the design of the flywheel. Justify the design if flywheel is already there.
7. Design a leaf springs for practical application (Automobiles) for the given conditions and constraints and find its practical availability.
8. Selection of a suitable ball bearing based on some practical application.

HEAT TRANSFER LAB.

Subject Code: BMEE1- 632 **L T P C**
0 0 2 1

A. Two to three students in a group are required to do one or two practicals in the form of Lab. Project in the topic/s related to the subject matter and in consultation with

teacher. The complete theoretical and experimental analysis of the concerned topic is required to be performed (including design and fabrication of new experimental set up, if required, or modifications/retrofitting in the existing experimental set ups). The following topics can be taken as reference:

1. Determination of thermal conductivity of:
   a) a solid insulating material by slab method
   b) powder materials by concentric spheres method / or by some transient heat transfer
   c) technique
   d) a metal by comparison with another metal by employing two bars when kept in series
   e) and / or in parallel under different boundary conditions
   f) Liquids by employing thin layer
   g) a composite wall.
2. Determination of coefficient of heat transfer for free/forced convection from the surface of
   a) Cylinder / plate when kept:
   b) Along the direction of flow
   c) Perpendicular to the direction of flow
   d) Inclined at an angle to the direction of flow
3. To plot the pool boiling curves for water and to determine its critical point
4. Determination of heat transfer coefficient for
   a) Film condensation
   b) Drop-wise condensation
5. Determination heat transfer coefficient by radiation and hence find the Stefan Boltzmann's constant using two plates/two cylinders of same size by making one of the plates/cylinders as a black body.
6. Determination of shape factor of a complex body by an analog technique.
7. To plot the temperature profile and to determine fin effectiveness and fin efficiency for
   i) A rod fin when its tip surface is superimposed by different boundary condition like.
      a) Insulated Tip
      b) Cooled Tip
      c) Temperature Controlled Tip
   ii) Straight triangular fins of various sizes and optimization of fin proportions
   iii) Circumferential fins of rectangular/triangular section

B. Each student is required to use Finite Difference Method for analysis of steady state one dimensional and two dimensional conduction problems (Minimum two problems one may be from the Lab. Project) such as conduction through plane / cylindrical / spherical wall with or without internal heat generation, heat transfer through fins, bodies with irregular boundaries subjected to different boundary conditions.

FLUID MACHINERY LAB.

Subject Code: BMEE1-633 **L T P C**
0 0 2 1

1. Determination of various efficiencies of Hydraulic Ram.
2. To draw characteristics of Francis turbine.
3. To draw characteristics of Kaplan Turbine.

4. To study the constructional features of reciprocating pump and to perform test on it for determination of pump performance.
5. To draw the characteristics of Pelton Turbine.
6. To draw the various characteristics of Centrifugal pump.
7. A visit to any Hydroelectric Power Station.

OPERATION MANAGEMENT

Subject Code: BMEE1 - 665 **L T P C** **Duration: 35 Hrs.**
3 0 0 3

UNIT-I

Need and Scope of Operation Management: Types of production system and their characteristics, productivity definition, types and measurements

Product Design and Development: Steps involved in product design and development, considerations of technical, ergonomic, aesthetic, economic and time factors. Use of concurrent engineering in product design and development.

UNIT-II

Planning and Forecasting: Role of market survey and market research in pre-planning, long medium and short range forecasting, objective and techniques of forecasting, smoothening and revision of forecast , PRODUCTION PLANNING: Production planning objective and functions, Bill of material, Capacity and man power requirement planning, operation analysis and process planning, long range planning, aggregate planning; Objective, Strategies, graphical and mathematical techniques of aggregate planning, master production scheduling, MRP and MRPII Systems.

UNIT-III

Production Control: Capacity control and priority control, production control functions; Routing, scheduling, dispatching, expediting and follow up. Techniques of production control in job shop production, batch production and mass production systems,

Material Management: Objectives, scope and functions of material management, planning, procurement, storing, ending and inventory control. Purpose of inventory, inventory cost, inventory control systems, Selective inventory control systems, Determination of EOQ, Lead time and reorder point. Methods of physical stock control.

UNIT-IV

Quality Control: Meaning of quality and quality control, quality of design, quality of conformance and quality of performance, functions of quality control. Introduction to statistical quality control-control charts and sampling plans

Management Information Systems: Introduction to MIS, steps in designing MIS, Role of Computers in MIS.

Learning Outcomes

The student will be able to:

1. Understand the fundamental theory of operation management.
2. Make forecasts in the manufacturing and service sectors using selected quantitative and Qualitative techniques.
3. Apply the principles and techniques for planning and control of the production and service systems to optimize/make best use of resources.
4. Understand the importance Quality in production.

Recommended Books

1. Charry, 'Production and Operation Management', Tata-McGraw Hill.
2. J.G. Monks, 'Production/Operation Management', Tata-McGraw Hill.
3. R.N. Nauhria and Rajnish Prakash, 'Management of Systems', Wheeler Publishing, New Delhi.
4. E.L. Grant and R.S. Leaven Worth, 'Statistical Quality Control', McGraw Hill.

INDUSTRIAL TRIBOLOGY

Subject Code: BMEE1- 666 **L T P C** **Duration: 35 Hrs.**
3 0 0 3

UNIT-I

Introduction: Tribology in design, tribology in industry Viscosity, flow of fluids, viscosity and its variation -absolute and kinematic viscosity, temperature variation, viscosity index determination of viscosity, different viscometers, Tribological considerations Nature of surfaces and their contact; Physic-mechanical properties of surface layer, Geometrical properties of surfaces, methods of studying surfaces; Study of contact of smoothly and rough surfaces

Friction and Wear: Role of friction and laws of static friction, causes of friction, theories of friction, Laws of rolling friction; Friction of metals and non-metals; Friction measurements. 2.1 Definition of wear, mechanism of wear, types and measurement of wear, friction affecting wear, Theories of wear; Wear of metals and non-metals.

UNIT-II

Hydrostatic Lubrication: Principle of hydrostatic lubrication, General requirements of bearing materials, types of bearing materials., Hydrostatic step bearing, application to pivoted pad thrust bearing and other applications, Hydrostatic lifts, hydrostatic squeeze films and its application to journal bearing, optimum design of hydrostatic step bearing

Hydrodynamic theory of lubrication: Principle of hydrodynamic lubrication, Various theories of lubrication, Petroffs equation, Reynold's equation in two dimensions -Effects of side leakage - Reynolds equation in three dimensions, Friction in sliding bearing, hydro dynamic theory applied to journal bearing, minimum oil film thickness, oil whip and whirl, anti -friction bearing, hydrodynamic thrust bearing.

UNIT-III

Air/gas Lubricated Bearing: Advantages and disadvantages application to Hydrodynamic journal bearings, hydrodynamic thrust bearings. Hydrostatic thrust bearings. Hydrostatic bearing Analysis including compressibility effect.

Lubrication and Lubricants: Introduction, dry friction; Boundary lubrication; classic hydrodynamics, hydrostatic and elasto hydrodynamic lubrication, Functions of lubricants, Types of lubricants and their industrial uses; SAE classification, recycling, disposal of oils, properties of liquid and grease lubricants; lubricant additives, general properties and selection.

UNIT-IV

Special Topics: Selection of bearing and lubricant; bearing maintenance, diagnostic maintenance of Tribological components and considerations in IC engines and automobile parts, roller chains and wire rope, lubrication systems; Filters and filtration.

Learning Outcomes

The focus of Tribology & Lubrication is the fundamentals of interfacial contact, adhesion, friction, wear and lubrication. By the end of the course student should:

1. Have a knowledge of surface topography and know how to model a rough engineering surface;
2. Have a clear overall picture about the basics of tribology and related sciences, theoretical background about processes in tribological system, mechanisms and forms of interaction of friction surfaces;
3. Understand Hertz contact and rough surface contact;
4. Be familiar with adhesion theories and the effect of adhesion on friction and wear;
5. Have a mastery of the friction/lubrication mechanisms and know how to apply them to the practical engineering problem;
6. Know the methods to reduce the friction for engineering surface

MECHATRONICS

Subject Code: BMEE1-668 **L T P C** **Duration: 36 Hrs.**
3 0 0 3

UNIT-I

Introduction: Definitions, trends, control systems, microprocessor / micro controller based controllers, PC based controllers, applications: SPM, robot, CNC machine, FMS, CIM.

Sensor Technology: Sensor and transducers, terminology, displacement, position, proximity - encoders, velocity – tacho generators, force - strain gauges, pressure, temperature-thermocouples, RTDs, thermistors, light sensors - photoelectric sensors, IR sensors, sensor selection.

Signal Conditioning: Introduction, the operational amplifier, protection, filtering, Wheatstone bridge, digital signals, multiplexers, data acquisition, digital signal processing, pulse-modulation.

UNIT-II

Precision Mechanical Actuation: Pneumatic actuation systems, electro-pneumatic actuation systems, hydraulic actuation systems, electro-hydraulic actuation systems, mechanical systems, types of motion, kinematics, inverse kinematics, timing belts, ball screw and nut, linear motion guides, linear bearings, harmonic transmission, bearings, motor / drive selection.

Electronic Devices and Circuits: Semiconductor devices, diodes and LEDS, zener diodes and voltage regulator, inductive kick, bandwidth, frequency %& response of a measurement system, bipolar transistor circuits, amplifiers.

UNIT-III

Electromechanical Drives: Relays and solenoids, stepper motors, DC brushed and brushless motors, DC servomotors, AC / DC motors for non-servo motion drives, braking methods, pulse width modulated, Bipolar driver, Mosfet drives, SCR drives, variable frequency drives

Digital Electronics: Digital logic, number systems, logic gates, Boolean algebra, Karnaughrnaps, sequential logic.

Microprocessors: Control, microcomputer structure, microcontrollers, digital interfacing, analog interfacing, DAC, ADC, applications.

UNIT-IV

Input / Output Systems: Interfacing, input / output ports, interface requirements, peripheral interface adapters, serial communication interface, direct memory access.

Control System: System transfer function, Laplace transformation and its applications, continuous and discrete processes, proportional control, integral control, differential control, PID

control, digital controllers, control system performance, controller tuning, adaptive control, frequency response, PLC, PMC, introduction to fuzzy logic and neural networks.

Recommended Books

1. Kamm, 'Understanding Electro-Mechanical Engineering - An Introduction to Mechatronics' Prentice-Hall of India.
2. Koren, 'Computer Control of Manufacturing System', McGraw Hill.
3. Groover, 'Production Systems and CIM', Prentice Hall of India.
4. Maleki, 'Flexible Manufacturing Systems', Prentice Hall of India.
5. B.C. Kuo, 'Feedback Control Systems', Prentice Hall of India.
6. Sabri Cetinkunt, 'Mechatronics', Wiley Publications, **2006.**

Learning Objectives

1. To enable the student to understand the modern mechatronics components;
2. To present the underlying principles and alternatives for mechatronics systems design;
3. To provide the student with the opportunity for hands-on experience with the related components of the technology for diverse domains of application;
4. To develop the student's ability to evaluate appropriate technology and create and devise
5. realistic industrial systems.

The students will be able to understand the difference between Heat transfer and Thermodynamics and will also learn different modes of heat transfer. He will be able to solve the practical problems related to heat transfer in Cartesian, Cylindrical and Spherical co-ordinates. He will also learn how to increase the rate of heat flow by using the extended surfaces and also the heat transfers with phase change.

SOLAR ENERGY

Subject Code: BMEE1 – 670 **L T P C** **Duration: 37 Hrs.**
3 0 0 3

Learning Objectives:

Upon successful completion of the course the students will be able to understand and apply

1. The characteristics and world distribution of solar radiation.
2. The solar radiation and measurement techniques.
3. The methods of calculation of solar radiation availability at a given location.
4. The fundamentals of thermal and direct conversion of solar energy to power.

UNIT-I

Energy Resources and Solar Spectrum: World energy resources - Indian energy scenario - Environmental aspects of energy utilization. Renewable energy resources and their importance – Global solar resources. Solar spectrum – Electromagnetic spectrum, basic laws of radiation. Physics of the Sun - Energy balance of the Earth, energy flux, solar constant for Earth, greenhouse effect

UNIT-II

Solar Radiation and Measurement: Solar radiation on the earth surface - Extraterrestrial radiation characteristics, Terrestrial radiation, solar isolation, spectral energy distribution of solar radiation. Depletion of solar radiation - Absorption, scattering. Beam radiation, diffuse and Global radiation. Measurement of solar radiation – Pyranometer, pyrheliometer, Sunshine recorder. Solar time - Local apparent time (LAT), equation of time (E)

UNIT-III

Solar Radiation Geometry and Calculations: Solar radiation geometry - Earth-Sun angles – Solar angles. Calculation of angle of incidence - Surface facing due south, horizontal, inclined surface and vertical surface. Solar day length – Sun path diagram – Shadow determination. Estimation of Sunshine hours at different places in India. Calculation of total solar radiation on horizontal and tilted surfaces. Prediction of solar radiation availability.

UNIT-IV

Solar Thermal Energy Conversion: Thermodynamic cycles – Carnot – Organic, reheat, regeneration and supercritical Rankine cycles - Brayton cycle – Sterling cycle – Binary cycles – Combined cycles. Solar thermal power plants - Parabolic trough system, distributed collector, hybrid solar-gas power plants, solar pond based electric power plant, central tower receiver power plant.

Solar Electrical Energy Conversion: Solar photovoltaic energy conversion - Principles - Physics and operation of solar cells. Classification of solar PV systems, Solar cell energy conversion efficiency, I-V characteristics, effect of variation of solar insolation and temperature, losses. Solar PV power plants.

Recommended Books

1. J.A. Duffie and W.A. Beckman, 'Solar Engineering of Thermal Processes', 3rd Edn., Wiley Publications, **2006.**
2. De Vos, 'Thermodynamics of Solar Energy Conversion', Wiley- VCH, **2008.**
3. H.P. Garg and J. Prakash, 'Solar Energy Fundamentals and Applications', Tata McGraw-Hill, **2005.**
4. S. Kalogirou, 'Solar Energy Engineering- Processes and Systems', Elsevier, **2009.**
5. R. Petela, 'Engineering Thermodynamics of Thermal Radiation for Solar Power', McGraw-Hill Co., **2010.**
6. D. Yogi Goswami, Frank Kreith, Jan F. Kreider, 'Principles of Solar Engineering', 2nd Edn., Taylor & Francis, **2003.**

ENERGY CONSERVATION AND MANAGEMENT

Subject Code: BMEE1-671 **L T P C** **Duration: 37 Hrs.**

3 0 0 3

UNIT-I

Introduction: Energy – Power – Past & Present scenario of World; National Energy Consumption Data – Environmental aspects associated with energy utilization –Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.

UNIT-II

ELECTRICAL SYSTEMS: Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors – Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.

UNIT-III

THERMAL SYSTEM: Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Steam: Distribution &U sage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories.

UNIT-IV

ENERGY CONSERVATION IN MAJOR UTILITIES: Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers – D.G. sets

ECONOMICS: Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept.

Recommended Books

1. L.C. Witte, P.S. Schmidt, D.R. Brown, 'Industrial Energy Management and Utilization', Hemisphere Publications, Washington, **1988**.
2. P.W. Callaghan, 'Design and Management for Energy Conservation', Pergamon Press, Oxford, **1981**.

REFRIGERATION AND AIRCONDITIONING

Subject Code: BMEE1- 734 **L T P C** **Duration: 42 Hrs.**
3 1 0 4

UNIT-I (12 Hrs.)

Basic Concepts: Definition of Refrigeration and Air conditioning; Difference between Refrigeration and cooling; Difference between Refrigeration and Air conditioning; Brief history of Refrigeration and Air conditioning; Natural and Mechanical Refrigeration; Applications of Refrigeration and Air conditioning; Definitions of refrigerant, cooling/ Refrigeration effect, cooling capacity, heating effect, heating capacity; Units of refrigeration; Coefficient of performance and Energy Efficient Ratio; COP of a refrigerator; and COP/EPR of a heat pump; Single Phase Reversed Carnot cycle and its limitations; Two Phase Reversed Carnot cycle and its limitations; Methods of Refrigeration; Numerical.

Gas Cycle Refrigeration and Aircraft Refrigeration & Air conditioning: Bell Coleman/Reversed Brayton / Reversed Joule Cycle and its analysis; Analysis of ideal thermodynamically coupled refrigerator and engine Numerical; Applications of Gas Cycle Refrigeration; Necessity of aircraft refrigeration and air conditioning; Classification of aircraft refrigeration and air conditioning systems; Simple/basic aircraft refrigeration and air conditioning system (with and without evaporative cooler); Need of evaporator cooler; Boot Strap aircraft refrigeration and air conditioning system (with and without evaporative cooler); Regenerative aircraft refrigeration and air conditioning system; Reduced Ambient aircraft refrigeration and air conditioning system; Performance of air-refrigeration systems; Dry Air Rated Temperature (DART); Comparison of different aircraft refrigeration and air conditioning systems; Numerical.

UNIT-II (11 Hrs.)

Vapour Compression Refrigeration Cycle: Vapour compression refrigeration system and its basic components; Representation of Simple/Theoretical vapour compression refrigeration cycle on h-s, T-s and P-h diagrams; C.O.P. from T-s diagram; Dry versus wet compression; expansion versus throttling of liquid refrigerant; Analysis of Simple/Theoretical vapour compression refrigeration cycle; Introduction of P-h diagram/chart and Refrigeration Tables; Optimum **C.O.P.:** Ewing analysis for maximum C.O.P.; Determination of properties of sub cooled, saturated and superheated refrigerant by using saturated properties & specific heat tables/saturated & superheated properties tables and P-h diagram; Compressor work and volumetric efficiency; Effect on performance and cooling capacity due to change in evaporator pressure, condenser pressure, sub cooling of liquid refrigerant, super heating of suction vapours,

use of liquid - vapour regenerative heat exchanger; Effect on performance and cooling capacity due to heat exchange of vapours with compressor cylinder walls, pressure drop in suction (wire drawing) and discharge valves, pressure drop in evaporator and condenser; Actual vapour compression refrigeration cycle on T-s and P-h diagrams (No mathematical analysis); Numericals. Flash gas, its advantages and disadvantages, and its removal: flash chamber, liquid sub-cooler; Introduction to compound (multistage) compression, its advantages, schematic representation of these systems with use of flash chamber, water intercooler, flash intercooler, liquid sub-cooler (independent and combination of these); Introduction to multiple evaporator systems, schematic representation of these systems with use of individual and multiple expansion valves arrangements, with single and multiple (individual and compound) compressor. Numericals.

Vapour Absorption Refrigeration Cycle (No Mathematical Analysis): Principle and advantages of vapour absorption refrigeration system over compression system; basic components of the vapour absorption refrigeration system; Desirable properties of absorption system refrigerant and absorbent; Aqua - ammonia vapour absorption refrigeration system; Lithium Bromide - water absorption system (Single and double effect); Electrolux refrigeration system; comparison between vapour absorption and compression systems.

UNIT-III (11 Hrs.)

Refrigerants: Classification and nomenclature of refrigerants; Desirable thermodynamic, chemical and physical properties of refrigerants; comparative study of commonly used refrigerants and their fields of application; Azeotropes; Zeotropes; Effect of moisture and oil miscibility; Refrigerants dying agents and antifreeze solution; leak detection and charging of refrigerants; environmental aspects of conventional refrigerants; Eco friendly refrigerants and action plan to reduce ecological hazards.

Alternative Refrigeration Systems and Low Temperature Refrigeration: (No Mathematical Analysis) Principle, advantages, limitations and applications of Steam Jet Refrigeration; Mixed Refrigeration Systems; Vortex Tube Refrigeration, Thermoelectric cooling; Trans critical Carbon Dioxide Compression Refrigeration; Cascade Refrigeration System; Linde and Claude cycles, Liquefication of gases, cryogenics and its engineering applications.

UNIT-IV (12 Hrs.)

Air Conditioning Concepts and Applications: Classification of air-conditioning systems; Psychrometry; Dry Air; Moist Air; Basic laws obeyed by Dry Air and Moist Air; Psychrometric properties of air: Dry bulb, wet bulb and dew point temperatures, Relative and specific humidity, degree of saturation adiabatic saturation temperature, enthalpy of air and water vapours; Psychrometric chart and its use; Adiabatic mixing of moist air streams without condensation and with condensation; Numerical.

Human requirement of comforts; effective temperature and comfort charts; Industrial and comfort air conditioning.

Psychometric Processes: Basic psychrometric processes; Sensible heat process; Latent heat process; Total heat process; Sensible heat factor; Evaporative cooling; cooling with dehumidification; Heating with dehumidification; chemical dehumidification; By-pass factor; Contact factor; Psychrometric processes in air conditioning equipment: Cooling coils, Heating coils, cooling and dehumidification coils, Evaporative coolers, Adiabatic dehumidifiers, Steam injection, mixing of air streams, Air washer ; Summer, winter and year round air conditioning systems; Numerical.

Calculations for Air Conditioning Load and for Rate and state of Supply Air: Sources of heat load; sensible and latent heat load; Cooling and heating load estimation; Apparatus dew point temperature; Rate and state of supply air for air conditioning of different types of premises; Numerical

Refrigeration and Air Conditioning Equipment: Brief description of compressors, condensers, evaporators and expansion devices; Cooling towers; Ducts; dampers; grills; air filters; fans; room air conditioners; split units; Package and central air conditioning plants. Thermal insulation for air conditioning systems.

Recommended Books

1. C.P. Arora, 'Refrigeration and Conditioning', Tata McGraw Hill.
2. Manohar Prasad, 'Refrigeration and Conditioning', Wiley Eastern Limited.
3. Jordan and Priester, 'Refrigeration and Conditioning', Prentice Hall of India.
4. W.F. Stoecker, 'Refrigeration and Conditioning', McGraw Hill.
5. Arora & Domkundwar, 'Refrigeration and Air conditioning', Dhanpat Rai.

REFRIGERATION AND AIRCONDITIONING LAB.

Subject Code: BMEE1-735 **L T P C**
0 0 2 1

1. Study of various elements of a vapour compression refrigeration system through cut section models / actual apparatus.
2. Study of tools used in refrigeration and air conditioning.
3. Study and performance testing of domestic refrigerator.
4. Study the performance testing of Electrolux refrigerator.
5. Study and performance testing of an Ice plant.
6. Calculation/ Estimation of cooling load for a large building.
7. Visit to a central Air conditioning plant for study of processes for winter and summer air conditioning
8. Visit to a cold storage for study of its working.
9. Study and performance testing of window type room air conditioner.
10. Study and performance testing of water cooler.

MECHANICAL VIBRATIONS

Subject Code: BMEE1 -773 **L T P C** **Duration: 36 Hrs.**
3 0 0 3

UNIT-I

Introduction: Basic concepts, Types of vibration, Periodic & Harmonic vibrations, Degrees of freedom, Scope of vibrations, Vibration models, Equivalent springs and dashpot, beats, Methods of vibration analysis.

UNIT-II

Vibration of Single Degree of Freedom System: Undamped free vibrations, and, torsional system, Rolling of a ship, damped free vibrations, critical damping, logarithmic decrement, Modelling of stiffness and damping, Coulomb damping, Equivalent viscous damping, Structural damping, damped force vibration system, estimation of damping by decay plots, forcing due to unbalance, measurement of damping, vibration due to a constant force, vibration isolation

transmissibility, Critical speeds or Whirling speeds, self-excited vibrations, coefficient of slip friction, vibration measuring instruments.

UNIT-III

Two degrees of Freedom Systems:

a) Principal modes of vibrations, natural frequencies, amplitude ratio, undamped free, damped free, forced harmonic vibration, semi-definite systems, torsional vibrations, combined rectilinear & angular modes; Lagrange's equation.
b) Application to un-damped and damped vibration absorbers: Vibration absorber – principle; centrifugal pendulum vibration absorber, dynamic vibration absorber, untuned dry friction and viscous vibration damper, torsional vibration absorber.
c) Generalized co-ordinates and co-ordinate coupling, geared system, Torsionally equivalent shaft, coupled pendulums.

UNIT-IV

Multi-degree of freedom systems: Undamped free vibrations, influence coefficients, Generalized coordinates, orthogonality principal, matrix methods, Rayleigh and Dunkerley, Holzer's, Stodola method, Mechanical impedance, Eigen values and Eigen vectors.

Continuous systems: Transverse vibrations of a string, longitudinal and harmonic vibrations of rods, transverse vibrations of beams, uniform beam and various boundary conditions, Euler's equation of motion for beam vibration, natural frequencies for various end conditions, torsional vibration of circular shafts.

Recommended Books

1. G.K. Grover, 'Mechanical Vibrations', Hem Chand and Bros.
2. K.K. Pujara, 'Mechanical Vibrations', Dhanpat Rai and Sons, Delhi.
3. V.P. Singh, 'Mechanical Vibrations', Dhanpat Rai and Sons, Delhi.
4. Debabrata Nag, 'Mechanical Vibration', John Wiley India.
5. Thomson, 'Mechanical Vibration', Prentice Hall.

NON-TRADITIONAL MACHINING

Subject Code: BMEE1-774 **L T P C** **Duration: 38 Hrs.**
3 0 0 3

UNIT-I

Basics of Non Traditional Machining Processes: Need for non-traditional Machining-Classification on the basis of energy sources—Consideration in process selection, materials, and applications.

Mechanical Energy Processes: Ultra-sonic Machining – Elements of the process, mechanism of metal removal, process parameters, economic considerations, Benefits and Applications - Advantages and limitations, recent developments Abrasive Jet Machining, Water Jet Machining and abrasive flow machining: Basic principles, equipments, process variables, mechanism of material removal, applications and limitations

Unit-II

Electrical Energy Processes: Electro Chemical process: Fundamentals of Electro chemical machining, electro-chemical grinding, electro chemical honing and deburring process, metal removal rate in ECM, surface finish and accuracy, economic aspects of ECM simple problems for estimation of metal removal rate, applications and limitations, recent developments.

Chemical Energy Processes: Chemical Machining, Photochemical Machining: Basic

principles equipment, process variables, mechanism of material removal, applications and limitations

UNIT-III

Thermo Electrical Energy Processes: General principles of Electrical discharge machining, Electrical discharge grinding and wire cut EDM process-power circuits for EDM, metal removal rate in EDM, process parameters, selection of tool electrode and dielectric fluids, surface finish and machining accuracy, characteristics of spark eroded surface and machine tool selection, recent developments.

UNIT-IV

Thermal Energy Processes: Electron beam machining, Plasma Arc Machining and Laser Beam Machining-Operating principles–Equipment and sub systems – Parameters influencing metal Removal-Benefits - Applications-Advantages and limitations, recent developments.

Hybrid Energy Processes: Concept, Classifications, applications, Advantages

Recommended Books

1. Pandey and Shan, 'Modern Manufacturing Process', Prentice Hall, New Jersey.
2. Vijay K Jain, 'Advanced Machining Processes", Allied Publishers, **2005.**
3. P.K. Mishra, 'Non-Conventional Machining', The Institution of Engineers (India), Text Book Series, New Delhi, **1997.**
4. G.F. Bennedict, 'Non-Traditional Machining Techniques', Marcel Decker, New York, **1990.**

HEAT EXCHANGER DESIGN

Subject Code: BMEE1-775 **L T P C** **Duration: 36 Hrs.**
3 0 0 3

1. **Basic Design Methodologies:** Classification of heat exchanger, selection of heat exchanger, Thermal-Hydraulic fundamentals, Overall heat transfer coefficient, LMTD method for heat exchanger analysis for parallel, counter, multipass and cross flow heat exchanger, e-NTU method for heat exchanger analysis, Fouling, Rating and sizing problems, heat exchanger design methodology
2. **Fouling of Heat Exchangers:** Basic consideration, effect of fouling on heat transfer and pressure drop, cost of fouling, design of heat exchangers subject to fouling, fouling resistance, cleanliness factor, techniques to control fouling
3. **Design of Double Pipe Heat Exchangers:** Thermal and Hydraulic design of inner tube and annulus, hairpin heat exchanger with bare and finned inner tube, total pressure drop
4. **Design of Shell & Tube Heat Exchangers:** Basic components, basic design procedure of heat exchanger, TEMA code, J-factors, conventional design methods, Bell-Delaware method
5. **Design of Compact Heat Exchangers**: Heat transfer enhancement, plate fin heat exchanger, tube fin heat exchanger, heat transfer and pressure drop
6. **Condensers and Evaporators**
   Condenser: Shell and tube condenser, plate condenser, air cooled condenser, direct contact condenser, condenser for refrigeration and air-conditioning, thermal design of shell and tube condenser
   Evaporator: Evaporator for refrigeration and air-conditioning, thermal analysis of evaporator, standards for evaporators and condensers

7. **Heat Transfer Enhancement and Performance Evaluation:** Enhancement of heat transfer, Performance evaluation of Heat Transfer Enhancement technique. Introduction to pinch analysis

Recommended Books

1. Sadik, Kakac, 'Heat Exchanger Selection, Rating and Thermal Design', CRC Press.
2. Ramesh K. Shah, 'Fundamentals of Heat Exchanger Design', Wiley Publication.
3. V.A. Kays and A.L. London, 'Compact Heat Exchangers', McGraw Hill.
4. T. Kuppan, 'Heat Exchanger Design Handbook', Marcel Dekker, CRC Press.
5. E.U. Schunder, 'Heat Exchanger Design Hand Book', Hemisphere Pub.
6. Donald Q. Kern, 'Process Heat Transfer', McGraw Hill.

MAINTENANCE ENGINEERING

Subject Code: BMEE1 - 776 **L T P C** **Duration: 38 Hrs.**
3 0 0 3

UNIT-I

Introduction: Evolution of maintenance, objective of maintenance, maintenance policies and philosophies, maintenance concept maintenance management & terotechnology, relationship with other functional areas, importance of maintenance, elements of good maintenance, economics of maintenance, training and safety aspects in maintenance.

UNIT-II

Maintenance Strategies: Classification of maintenance programs, corrective, preventive and predictive maintenance, comparison of maintenance programs, preventive maintenance- concept functions, benefits, limitations. Condition Based Maintenance (CBM); Objectives, what to monitor, when to monitor, principles of CBM, condition based maintenance techniques, performance monitoring, vibration monitoring, current monitoring, oil debris/spectroscopy, thermography and corrosion monitoring, steps in implementation of CBM, benefits of CBM.

UNIT-III

Reliability Centered Maintenance (RCM): RCM logic, maintenance and RCM, benefits of RCM, total productive maintenance (TPM), introduction, key supporting elements of TPM, methodology, evaluation and benefits. Non-Destructive Testing (NDT): Purpose and challenges; Techniques, visual aids-borescopes, endoscopes, fibre optics scanners, magnetic particles inspection, liquid penetrants, eddy current, ultrasonic radiography, selection of NDT techniques, merits/demerits and applications of various techniques.

UNIT-IV

Maintenance Planning and Control: Basic ingredients, basic steps in maintenance management, maintenance planning and control system, documentation, maintenance productivity areas for improvement. Reliability, Maintenance & Availability: Techniques for improvement of operational reliability, safety and availability of machines and production systems, maintainability criteria, checklist to assess the maintainability of a system, maintainability programs, objectives, key issues in availability improvement program, fault diagnosis, pareto principle Ishikawa diagram.

Learning Outcomes

1. To enable the students to understand the principles, functions adapted in industry for the successful management of maintenance activities.
2. To understand the different types of maintenance strategies.

3. Understand the strategic role of Maintenance/Reliability engineering in asset life cycle optimization.
4. Apply analytical skills and problem-solving tools/techniques to the fault analysis of various machines and equipment.

Recommended Books

1. L.R. Higgin. 'Maintenance Planning and Control', McGraw Hill Book Company.
2. Kelley Anthony, 'Maintenance Planning and Control', East-West Press Pvt. Ltd.
3. B.S. Blanchard, E.E. Lowey, 'Maintainability: Principle and Practices', McGraw Hill.
4. B. Raj, T. Jayakumar, K. Thavasimutyi, 'Practical NDT', Narora Publishing House.
5. Niebel Benjamin W., 'Engineering Maintenance Management', Marcel Dekker.

NON-DESTRUCTIVE TESTING

Subject Code: BMEE1-777 **L T P C** **Duration: 38 Hrs.**
3 0 0 3

Learning Objectives

1. To understand the Need and Significance of Non Destructive Testing methods and fundamental concepts of Non-Destructive Testing**.**
2. To understand the nondestructive testing methods that is usually employed to locate defects. Advantages and disadvantages of ultrasonic inspection as compared to other methods for nondestructive inspection of metal parts.
3. To understand various magnetizing methods that may be used for practically any steel part in the magnetic particle method.
4. To understand the radiography and its practical applications, X-ray and Gamma –ray along with effect of variables on radiographs.

UNIT-I

Introduction: Scope and Classification of techniques of material testing, Need and Significance of Non Destructive Testing methods, Comparison with Destructive Testing, type of Non Destructive testing methods. Liquid penetrant testing, Principle, Equipment and procedure, Characteristics of Developers.

Magnetic Particle Testing: Basic principles, scope and applications, magnetic analysis of steel bars and tubing magnetization methods, equipment, inspection medium, Demagnetization. advantages and disadvantages of Magnetic particle testing.

Ultrasonic Testing: Basic principles, flaw detection in rails and tubes (Sperry Detector), Ultrasonic testing surface roughness, Detection of defects in ferrous and non-ferrous metals, plastics, ceramics, measurement of thickness, hardness, stiffness, sonic material analyzer, concrete test hammer.

Radiographic Examination: Radiant energy and radiography, practical applications, X-ray and Gamma –ray equipment, effect of variables on radiographs, requirement of a good radiograph, interpretation of radiograph, safety precautions, Xeroradiography.

LEARNING OUTCOMES:

CO1: To develop fundamental concepts of Non Destructive Testing methods and able to Select the appropriate technique for a given application.

CO2: The students will learn Basic principles, scope and applications, magnetic particle testing of steel bars and tubing.

CO3: They will understand Detection of defects in ferrous and nonferrous metals, plastics, by using Basic principles of Ultrasonic testing.

CO4: Upon completion of the course, the students will be able to understand the interpretation of radiograph and safety precautions. Students expected to show ability to understand the difference in the different methods of nondestructive techniques, their advantages and disadvantages.

PROGRAMME OUTCOMES ADDRESSED IN THIS COURSE:

PO1: An ability to apply knowledge of Mechanical Engineering, applied mathematics, applied sciences and introductory engineering concepts.

PO5: An ability to create and apply the techniques, skills, and modern Mechanical engineering tools to complex engineering activities within constraints.

PO7: An ability to understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

LEARNING OUTCOMES- PROGRAMME OUTCOMES MAPPING TABLE

Course Outcomes	Programme Outcomes			Remarks
	PO1	PO5	PO7	Remarks
CO1	High	Medium	Medium	
CO2	High	Medium	High	
CO3	High	High	High	
CO4	High	High	High	
CO5	High	High	High	

Recommended Books

1. H.E. Davies, G.E. Troxell and G.F.W. Hauck, 'The Testing of Engineering Materials', McGraw Hill.
2. W.H. Armstrong, Mechanical Inspection, McGraw Hill.
3. P.J. Shull, 'Nondestructive Evaluation - Theory, Techniques, and Applications', Marcel Decker Inc., **2002**.
4. D.E. Bray and R.K. Stanley, 'Non-destructive Evaluation - A Tool in Design, Manufacturing and Service', CRC Press, **1996**.
5. 'NDT Hand Books', Vol 1-17, ASNT Press, OH, USA, **2012**.
6. Baldev Raj, T. Jaya Kumar, 'Practical Non-destructive Testing', Woodhead Publishing Ltd., **2002**.
7. Paul E. Mix, 'Introduction to NDT: A Training Guide', John Wiley, **2005.**

AUTOMOTIVE CONTROL

Subject Code: BMEE1-778 **L T P C** **Duration: 38 Hrs.**

3 0 0 3

1. **Introduction of Common Technology**: Engine related systems. Ignition system, computer controlled petrol fueling injection systems, Engine management systems, Anti-lock braking systems, Traction control system, Stability Control system, air conditioning, computer controlled diesel engine system.

2. **Computer ECM**: Fundamental parts of computer, Principles of operation, Computer data, Computer interfaces, Computer memories, Adaptive operating strategy of the ECM.
3. **Digital Electronics:** Logic gates, truth tables, Application of Logic gates, Flip-Flop, Analogue to Digital Conversion, Digital to Analogue conversion, Digital Displays (LED Display and Liquid crystal displays).
4. **Sensors:** Introduction of sensors and transducers Electromagnetic Sensors, Optical sensors, variable resistance type sensors, temperature sensors, Pressure sensors, variable capacitance sensors, Flow sensors, Piezoelectric sensors, Oxygen Sensor, Practical Importance of sensors.
5. **Actuators:** Introduction of Actuators, Actuators operation, Injectors, Exhaust gas recirculation actuators, motors, Solenoids, ABS actuators.
6. **Additional Technology:** Computer performance, Supplementary restraint systems(SRS), Coded ignition key, Fault tracing, Precautions when working with computer controlled system.

Recommended Books

1. Allan W.M. Bonnick, 'Automotive Computer Controlled Systems', Butterworth-Heinemann: A Division of Reed Educational and Professional Publishing Ltd.
2. Willium B. Ribbens, Willium B. Ribbens, 'Understanding Automotive Electronics', Elsevier Science, **2003.**
3. Ronald K. Jurgen, 'Sensors and Transducers', SAE, **2003.**
4. Jack Erjavec, 'Automotive Technology' Robert Scharff Delmar Publications Inc., **1992.**

CAD/CAM

Subject code: BMEE1-838 **L T P C** **Duration: 36 Hrs.**
3 0 0 3

UNIT-I

Fundamentals of CAD: Design process with and without computer; CAD/CAM system and its evaluation criteria, brief treatment of input and output devices, display devices; Functions of a graphics package and Graphics standard GKS, IGES and STEP; Modeling and viewing; Application areas of CAD.

Geometric Transformations: Mathematics preliminaries, matrix representation of 2 and 3 dimensional transformations: Concatenation of transformation matrices. Application of geometric transformations

UNIT-II

Geometric Modeling: Wireframe model: solid modeling: Boundary Representation (B-rep), Constructive Solid Geometry (CSG), Parametric Modeling Technique; Mass, volumetric properties calculations; surface modeling, concepts of hidden-line removal and shading: Mechanical Assembly Kinematics analysis and simulation.

Representation of Curves and Surfaces: Non-parametric and parametric representation of curves. Parametric representation of Hermite Cubic, Beizer and B-spline curves; Surface and its analysis. Representation of Analytical and synthetic surfaces.

Overview of FEM, Advantages and applications, recent advance in FEM, FEA software Basic principles and general procedure of FEM.

UNIT-III

NC/CNC Machine Tools: NC machine tools- basic components, coordinate systems; features of NC machine tools.

Computerized Numerical Control (CNC): Tooling for NC machines - tool presetting equipment, flexible tooling, tool length compensation, tool path graphics; NC motion control system; Manual part programming, fixed/floating zero. Block format and codes: Computer assisted part programming. DNC and Adaptive Control: Direct numerical control: Adaptive control in machining system; Combined DNC/CNC system.

Group Technology (GT): Part families; part classification and coding system: Group technology machine cells: Advantages of GT.

UNIT-IV

Computer Aided Process Planning: Introduction and benefits of CAPP. Types of CAPP systems, machinability, data selection systems in CAPP.

Computer Integrated Manufacturing Systems: Basic Concepts of CIM: CIM Definition, The meaning of Manufacturing, Types of Manufacturing systems; Need, Elements, Evolution of CIM; Benefits of CIM; Flexible Manufacturing Systems: Physical Components of an FMS. Types of Flexibility, Layout Considerations; FMS benefits

Recommended Books

1. Mikell P. Groover and Emory W. Zimmers,' CAD/CAM', PHI.
2. D.D. Bedworth, M.R Henderson & P.M. Wolfe, 'Computer Integrated Design and Manufacturing', Tata McGraw Hill.
3. Zeid Ibraham, 'CAD/CAM - Theory and Practice', Tata McGraw Hill.
4. P.N. Rao, 'CAD/CAM', Tata McGraw Hill.
5. C. Elanchezhian, G. Shanmuga Sundar, 'Computer Aided Manufacturing (CAM)', Firewall Media.

OPERATION RESEARCH

Subject Code: BMEE1 - 839 **L T P C** **Duration: 45 Hrs.**
3 1 0 4

UNIT-I

Introduction: Introduction to Operations Research: 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.

UNIT-II

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.

Sequencing Models: Solution of Sequencing Problem – Processing n Jobs through 2 Machines – Processing n Jobs through 3 Machines – Processing 2 Jobs through m machines– Processing n Jobs through m Machines.

UNIT-III

Dynamic Programming: Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems,

Game Theory: Competitive games, rectangular games, saddle point, minimax (maxim in) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.

UNIT-IV

Replacement Models: Replacement of Items that Deteriorate whose maintenance costs increase with time without change in the money value. Replacement of items that fail suddenly: individual replacement policy, group replacement policy.

Inventory Models: Inventory costs. Models with deterministic demand – model (a) demand rate uniform and production rate infinite, model (b) demand rate non-uniform and production rate infinite, model (c) demand rate uniform and production rate finite.

Learning Outcomes:

After The course the student will be able to

1. Solve simple and complex optimization models and implement in software.
2. Formulate and solve transportation problems for cost minimization.
3. Formulate and solve different inventory model problems for the different type of industries.
4. Will be able to carry out economical replacement analysis for obsolete /worn out industrial equipment.
5. Will be able to solve job sequencing problems for 2/3 machines for minimum cost/time models.

Recommended Books

1. P. Sankara Iyer, 'Operations Research', Tata McGraw-Hill.
2. A.M. Natarajan, P. Balasubramani, A. Tamilarasi, 'Operations Research', Pearson Education.
3. J.K. Sharma, 'Operations Research Theory & Applications,' Macmillan India Ltd.
4. P.K. Gupta and D.S. Hira, 'Operations Research', S. Chand & Co.
5. J.K. Sharma., 'Operations Research, Problems and Solutions', 3rd Edn., Macmillan India Ltd.

OPTIMIZATION TECHNIQUES

Subject Code: BMEE1-879 **L T P C** **Duration: 37 Hrs.**

3 0 0 3

UNIT-I

Introduction: Historical Development; Engineering applications of Optimization; Optimization techniques – classical and advanced techniques. Art of Modeling Origin of OR and its role in solving industrial problems: General approach for solving OR problems. Classification of mathematical models: various decision making environments.

UNIT-II

Linear Programming: Formulation of linear mathematical models: Graphical and simplex techniques for solution of linear programming problems, Motivation of simplex method, Simplex algorithm and construction of simplex tableau; Simplex criterion; Minimization versus maximization problems, Big-M method and two phase method, Introduction to duality theory and sensitivity analysis.

UNIT-III

Transportation and Assignment Models: Various initial basic feasible solutions methods, Optimization of transportation and assignment using different methods considering the concept of time and cost function.

Dynamic Programming: Characteristics of dynamic programming problems, deterministic dynamic programming, and probabilistic dynamic programming.
Queuing Theory: Basic structure of queuing model, Types of queuing situation: Queuing models with Poisson's input and exponential service, their application to simple situations.

UNIT-IV

Network Models: Shortest route and traveling sales man problems, PERT & CPM, analysis of time bound project situations, construction of networks, identification of critical path, slack and float, crashing of network for cost reduction.
Non-linear Programming Models: Graphical illustration to non-linear programming problems, introduction to different types of non-linear programming problems. Problems related to the topic.

RECOMMENDED BOOKS:

1. H.A. Taha, Operations Research, Prentice Hall of India, New Delhi.
2. H.M Wagner, Principles of Operations Research, Prentice Hall.
3. P.K. Gupta and D.S. Hira, Operations Research, S. Chand & Co.
4. F.S. Hiller and G.I. Libermann, Introduction to Operation Research, Holden Ray.
5. A Management Guide to PERT/CPM Wiest & Levy Prentice Hall

LEAN MANUFACTURING

Subject Code: BMEE1-880 **L T P C** **Duration: 38 Hrs.**
3 0 0 3

UNIT-I

Lean Production: Introduction, background, and lean thinking, importance of philosophy, strategy, culture, alignment, focus and systems view. Discussion of Toyota Production System. Lean Production Preparation: System assessment, process and Value-stream mapping, sources of waste.

UNIT-II

Lean Production Processes, Approaches and Techniques: Importance of focusing upon flow. Tools include: Workplace organization – 5S, Stability, Just-In-Time – One-piece flow – Pull, Cellular systems, Quick change and set-up reduction methods, Total productive maintenance, Poka-Yoke– mistake proofing, quality improvement, Standards, Leveling and Visual management, Six Sigma.

UNIT-III

SMED Single minute exchange of dies – theory and practice of the SMED system, the structure of production, Set-up operations, Fundamentals of SMED, Techniques for applying SMED, Basic examples of SMED.

UNIT-IV

Employee Involvement: Teams, Training, Supporting and encouraging involvement – Involving people in the change process; communication; importance of culture. Concurrent Engineering: Obeya in Toyota's new product development process, cross functional teams, use of computer technology, information management for simultaneous engineering.

Learning Outcomes

The students will be able to

1. Identify and understand the key requirements and concepts in lean manufacturing to initiate a continuous improvement change program in a manufacturing organization.

2. Apply the tools in lean manufacturing to analyze a manufacturing system and plan for its improvements.

Recommended Books

1. D. Womack and D. Jones, 'Lean Thinking', Free Press, **2003.**
2. J. Womack, D. Jones and D. Roos, 'The Machine that Changed the World', Rawson Associates, **1990.**
3. P. Dennis, 'Lean Production Simplified', Productivity Press, **2007.**
4. S. Shingo, 'A Revolution in Manufacturing: The SMED System', Productivity Press, **1985.**
5. J. Liker, 'The Toyota Way', McGraw-Hill, **2004.**
6. J. Liker and D. Meier, 'The Toyota Way', Field book, McGraw Hill, **2006.**

STATISTICAL QUALITY CONTROL

Subject Code: BMEE1 - 882 **L T P C** **Duration: 38 Hrs.**
3 0 0 3

UNIT-I

Introduction: Definition and Need of quality, Aspects of quality, Quality characteristic, Quality specification, Quality function, Economics of quality. Inspection, Its objectives and types, Inspection versus Quality Control, Statistical Quality Control, its Tools, Advantages, limitations and Applications.

Probability & Statistics: Definition, Laws, Probability Distributions (Normal Binomial, Poisson, Exponential) & related problems. Measures of Central tendency & Dispersion, Concept of Variation, Variable and attribute data, Frequency distribution.

UNIT-II

Control Charts: Concept of variability, Assignable and chance causes, Concept of specifications and tolerances, Definition and objectives of control charts, Control charts for variables and attributes and related problems, Variable charts vs attribute charts, Patterns on control charts, Type–I & Type-II Errors, Process capability and its methods of determination.

UNIT-III

Acceptance Sampling: Definition, Advantages over 100% inspection, Methods of taking samples, Operating characteristics curve & its characteristics. Single, Double and Multiple, Sequential Sampling Plan & Related problems.

Quality Assurance: Need, Principles, Essentials and Advantages of Quality Assurance System, Quality Manual, Field complaints, Quality Audit & its types, Quality Assurance Methods, Quality Control vs. Quality Assurance.

UNIT-IV

Quality Systems: Description of ISO: 9000 series of standards, ISO: 9001–2000 Systems. Description of TQM, Concept of Quality Circles, JIT System, Taguchi's Concept of Quality, Zero Defect Concept, 6s Concept and 5S.

Learning Outcomes

The student will learn

1. Concepts of quality control.
2. Principles and techniques of quality control.
3. Implementation of quality control.
4. Standards used for quality control.

Recommended Books

1. M. Mahajan, 'Statistical Quality Control', Dhanpat Rai & Co.
2. Amitav Mitra, 'Fundamentals of Quality Control', Pearson Education.
3. E.L. Grant & R.S. Leavenworth, 'Statistical Quality Control', McGraw Hill & Co.
4. Feigenbaum, 'Total Quality Control', McGraw Hill & Co.
5. D.C. Montgomery DC, 'Introduction to Statistical Quality Control', John Wiley & Sons Inc.
6. Stephan B. Vardeman, J. Marcus Jobe, 'Statistical QA Methods for Engineers', John Wiley & Sons Inc.
7. J.R. Taylor, 'Quality Control systems', McGraw Hill Int. Education.

ADDITIVE MANUFACTURING

Subject Code: BMEE1-883 **L T P C** **Duration: 38 Hrs.**
3 0 0 3

UNIT-I

Introduction to Rapid Prototyping: Classification of Manufacturing Processes, Introduction to Rapid Prototyping and Additive Manufacturing, History of development of RP, Engineering design process, Rapid Prototyping and its Impact, Product development, Product Prototyping and Product Development

Product Prototyping: Need of Product Prototyping, Prototype Planning and Management, Product and Prototype Cost Estimation, Prototype Design Methods and tools

UNIT-II

CAD Modeling: Geometrical Modelling Techniques, Wireframe Modelling, Surface Modelling and solid modeling, Slicing methods and software

UNIT-III

Rapid Prototyping Processes: Rapid Prototyping Overview, Rapid Prototyping Procedure, Liquid-Based RP Processes, Solid-Based RP Processes, Powder-Based RP Processes, Prototyping Materials, Modeling of Material Properties, Modeling and Design of Materials and Structures.

Direct Digital Prototyping and Manufacturing: Solid Models and Prototype Representation, Reverse Engineering for Digital Representation, Prototyping and Manufacturing Using CNC Machining, Fully Automated Digital Prototyping and Manufacturing.

UNIT-IV

Direct Methods for Rapid Tool Production: Classification of Direct Rapid Tool Methods, Direct ACESTM Injection Moulds, Laminated Object Manufactured (LaM) Tools, DTM Rapid Tool, Sand Form, EOS Direct Tool Process, Direct Metal Tooling using 3Dp.

Applications of Rapid Prototyping: Functional Models, Rapid Tooling, Rapid Manufacturing, Engineering Applications, Medical Model, and Art Models, Engineering Analysis Models.

Indirect Methods for Rapid Tool Production: Metal Deposition Tools, RTV Tools, Epoxy Tools, Ceramic Tools, Cast Metal Tools, Investment Casting, Fusible Metallic Core, Sand Casting, Keltool Process.

Recommended Books

1. Frank W. Liou, 'Rapid Prototyping and engineering Applications', CRC Press, **2007.**
2. D.T. Pham and S.S. Dimov, 'Rapid Manufacturing', Springer.
3. Kevin Otto, Kristin Wood, 'Product Design', Pearson.

INDUSTRIAL SAFETY AND ENVIOREMENT

Subject Code: BMEE0 –F91 **L T P C** **Duration: 38 Hrs.**
3 0 0 3

UNIT-I

Meaning & Need for Safety: Relationship of safety with plant design, equipment design and work environment. Industrial accidents, their nature, types and causes. Assessment of accident costs; prevention of accidents. Industrial hazards, Hazard identification techniques, Accident investigation, reporting and analysis.

UNIT-II

Planning for Safety & its Measures: Definition, purpose, nature, scope and procedure. Range of planning, variety of plans. Policy formulation and implementation of safety policies. Safety measures in a manufacturing organization, safety and economics, safety and productivity. Employees participation in safety. Safety standards and legislation.

UNIT-III

Meaning of Environment and Need for Environmental Control: Environmental factors in industry. Effect of temperature, Illumination, humidity noise and vibrations on human body and mind. Measurement and mitigation of physical and mental "fatigue" Basics of environment design for improved efficiency and accuracy at work. Environment Standards: Introduction to ISO 14000; Environment standards for representative industries.

UNIT-IV

Ventilation and heat Control Purpose of ventilation, Lighting, Noise & Vibrations: Physiology of heat regulation. Thermal environment and its measurement. Thermal comfort. Indices of heat stress. Thermal limits for comfort, efficiency and freedom from health risk. Natural ventilation. Mechanical ventilation. Air conditioning Process ventilation. Control of heat exposures: control at source, insulation, and local exhaust ventilation. Control of radiant heat, dilution ventilation. Local relief. Industrial Lighting: Purpose of lighting, benefits of good illumination. Phenomenon of lighting and safety. Lighting and the work. Sources and types of artificial lighting. Principles of good illumination. Recommended optimum standards of illumination. Design of lighting installation. Maintenance standards relating to lighting and colour. Noise & Vibrations: Continuous and impulse noise. The effect of noise on man. Noise measurement and evaluation of noise. Noise isolation. Noise absorption techniques. Silencers vibrations: Effect, measurement and control measures.

Learning Outcomes

1. Understand importance of safety at work
2. Understand various safety measures and how it leads to increasing plant productivity.
3. Understand basics of environmental design
4. Understand the control of Ventilation and heat etc.

Recommended Books

1. H.W. Heinrich, ‘Industrial Accident Prevention’, McGraw Hill.
2. Beranek, ‘Noise Reduction’, McGraw Hill.
3. D.C. Reamer, ‘Modern Safety and Health Technology’, R. Wiley.