PUNJAB TECHNICAL UNIVERSITY
KAPURTHALA

Scheme& Syllabus of
B. Tech. Mechanical Engineering [M.E.]

for Batch 2011

By
Board of Studies Mechanical Engineering/ Production Engineering / Industrial Engineering

Third Semester

Contact Hours: 34 Hrs.

Course Code	Course Name	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTME301	Strength of Materials- I	3	1	-	40	60	100	4
BTME302	Theory of Machines-I	3	1	-	40	60	100	4
BTME303	Machine Drawing	1	-	6	40	60	100	4
BTME304	Applied Thermodynamics -I	4	1	-	40	60	100	5
BTME305	Manufacturing Processes – I	4	-	-	40	60	100	4
BTME306	Engineering Materials & Metallurgy	3	-	-	40	60	100	3
BTME307	Engineering Materials & Metallurgy Lab	-	-	2	30	20	50	1
BTME308	Strength of Materials Lab.	-	-	2	30	20	50	1
BTME309	Applied Thermodynamics Lab	-	-	2	30	20	50	2
Advisory Meeting		-	-	1	-	-	-	-
BTME 310	Workshop Training*****	-	-	-	60	40	100	1
	Total	**18**	**3**	**13**	**390**	**460**	**850**	**29**

*** Workshop Training will be imparted in the Institution at the end of 2nd semester for Four (04) weeks duration (Minimum 36 hours per week). Industrial tour will also form part of this training.**

Fourth Semester

Contact Hours: 32 Hrs.

Course Code	Course Name	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTME401	Strength of Materials – II	4	1	-	40	60	**100**	5
BTME402	Theory of Machines – II	4	1	-	40	60	**100**	5
BTME403	Fluid Mechanics	4	1	-	40	60	**100**	5
BTME404	Applied Thermodynamics - II	4	2	-	40	60	**100**	5
BTME405	Manufacturing Processes-II	4	-	-	40	60	**100**	4
BTME406	Fluid Mechanics Lab	-	-	2	30	20	**50**	1
BTME407	Manufacturing Processes Lab	-	-	2	30	20	**50**	1
BTME408	Theory of Machines Lab	-	-	2	30	20	**50**	1
Advisory Meeting		-	-	1	-	-	-	-
General Fitness		-	-	-	100	-	**100**	-
	Total	**20**	**05**	**07**	**390**	**360**	**750**	27

Annex. I

B.Tech. (Mechanical)

5th Semester B.Tech (Mechanical)								
Code	**Title of the course**	**L**	**T**	**P**	**Maximum Marks**		**Total Marks**	**Credits**
					Internal	**External**		
BTAM-500	Mathematics-III	3	1	-	40	60	**100**	4
BTME-501	Design of Machine Elements – I	4	2	-	40	60	**100**	6
BTME-502	Computer aided Design and Manufacturing	4	-	-	40	60	**100**	4
BTME-503	Mechanical Measurement and Metrology	4	-	-	40	60	**100**	4
BTME-504	Industrial Automation and Robotics	4	-	-	40	60	**100**	4
BTME-505	Automobile Engineering	4	-	-	40	60	**100**	4
BTME-506	Computer aided Design and Manufacturing Lab	-	-	2	30	20	**50**	1
BTME-507	Mechanical Measurement and Metrology Lab.	-	-	2	30	20	**50**	1
BTME-508	Industrial Automation and Robotics Lab			1*	15	10	**25**	0.5
BTME-509	Automobile Engineering Lab			1*	15	10	**25**	0.5
	Advisory meeting	-	-	1	-	-	-	
IT 500	**Industrial Training	-	-	-	60	40	**100**	
	Total	**23**	**3**	**7**	**390**	**460**	**850**	29

Total Contact Hours = 33

***The students will attend these labs for two hours on every alternative turn.**

****The marks of Industrial/Institutional Training imparted at the end of 4th Semester will be included here.**

Sd
12/7/13

B.Tech. (Mechanical)

6th Semester B.Tech (Mechanical)								
Code	**Title of the course**	**L**	**T**	**P**	**Maximum Marks**		**Total Marks**	**Credits**
					Internal	**External**		
BTME-601	Design of Machine Elements –II	4	2	0	40	60	**100**	6
BTME-602	Heat Transfer	4	1	-	40	60	**100**	5
BTME-603	Fluid Machinery	3	1	-	40	60	**100**	4
BTME-604	Statistical and Numerical Methods in Engineering	3	1		40	60	**100**	4
BTME- DE	Departmental Elective-I	4	-	-	40	60	**100**	4
BTME-605	Heat Transfer Lab.	-	-	2	30	20	**50**	1
BTME 606	Fluid Machinery lab	-	-	2	30	20	**50**	1
BTME-607	Minor Project*	-	-	2	30	20	**50**	1
	Advisory meeting	-	-	1	-	-	-	
GF-600	General Fitness	-	-	-	100	-	**100**	
	Total	**18**	**5**	7	390	360	**750**	26

Total Contact Hours = 30

***The project work will be carried out in parts as minor project in 6th semester and major project in 7/8th semester. The literature survey, problem formulation, assessment for viability of the project, objectives and methodology for the project shall be decided in 6th semester. The same project problem is to be extended in the major project in 7th/8th semester. The minor project may be carried out by a group of students (2 to 4)**

Sd
12/7/13

B.Tech. (Mechanical)

7th /8th Semester B.Tech (Mechanical) * Industrial Training (One Semester)					
Code	**Title of the course**	**Maximum Marks**		**Total Marks**	**Credits**
		Internal	**External**		
BTME-IT	**Software Training**	150	100	**250**	**8**
	Industrial oriented Project Training	300	200	**500**	**10**
		450	300	**750**	**18**
Total Contact Hours per Week = 36 (minimum)					
*** Industrial Training in reputed industries will be arranged for complete one semester.**					

7th /8th Semester B.Tech (Mechanical)								
Code	**Title of the course**	**L**	**T**	**P**	**Maximum Marks**		**Total Marks**	**Credits**
					Internal	**External**		
BTME-801	Industrial Engineering and Management	4	-	-	40	60	**100**	4
BTME-802	Refrigeration & Air Conditioning	4	1	-	40	60	**100**	5
BTME-803	Mechanical Vibrations	4	1		40	60	**100**	5
BTME-DE/	Department Elective-II	4	-	-	40	60	**100**	4
	Open Elective	4			40	60	**100**	4
BTME-804	Refrigeration & Air Conditioning Lab	-	-	2	30	20	**50**	1
BTME-805	Mechanical Vibration lab	-	-	2	30	20	**50**	1
BTME-806	Major Project*	-	-	6	100	50	**150**	3
	Advisory meeting	-	-	1	-	-	-	-
GF 800	General Fitness	-	-	-	100	-	**100**	-
	Total	**20**	**2**	**11**	**460**	**390**	**850**	27
Total Contact Hours = 33								
*** The problem of the minor project "formulated" during 6th Semester is to extended and executed in major project by the same group of students. The design/construction/fabrication/computer modeling/experimentation etc. is to be carried out. The results and analysis followed by discussion regarding suitability /non suitability of the project or any positive gain in the project made with conclusions and recommendations for future extension of the project must be covered.**								

Sd 12/7/13

Department Electives

Group-1

DE/ME-1.1 I.C Engines
DE/ME-1.2 Cryogenic Technology
DE/ME-1.3 Non Conventional Energy resources
DE/ME-1.4 Energy Conservation and Management
DE/ME-1.5 Fluid Mechanics-II
DE/ME-1.6 Solar Energy
DE/ME-1.7 Heat Exchanger Design
DE/ME-1.8 Power Plant Engg.
DE/ME-1.9 Gas Dynamics

Group-2
DE/PE-2.0 Non-Traditional Machining
DE/PE-2.1 Industrial Engg
DE/ME-2.2 Modeling and Simulation
DE/ME-2.3 Operations Management
DE/ME-2.4 Non -Destructive Testing
DE/ME-2.5 Total Quality Management
DE/ME-2.6 Maintenance and Reliability Engg
DE/ME-2.7 Material Management
DE/ME-2.8 Management Information System
DE/ME-2.9 Entrepreneurship

Group-3
DE/PE-3.0 Product Design and Development
DE/PE-3.1 Machine Tool Design
DE/PE-3.2 Optimization Techniques
DE/ME-3.3 Tool Design
DE/ME-3.4 Finite Element Method
DE/ME-3.5 Experimental Stress Analysis
DE/ME-3.6 Industrial Tribology
DE/ME-3.7 Theory of plasticity
DE/ME-3.8 Mechatronics

Note:

1. A Department Elective subject may normally be offered only if at least 10 students of the class have opted for it

2. The student shall select both the electives courses from the same group out of three groups (Group-1, Group-2, and Group –3)

Sd/ 12/7/13

Third Semester

BTME 301 Strength of Materials – I

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 beam 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, stresses in struts and columns subjected to axial load; bending stress, slope and deflection under different loading and supporting conditions. After the study of this course, a student is expected to analyze different stresses, strains and deflection for designing a simple mechanical element under various loading conditions.

Unit –I

Simple, Compound Stresses and Strains: Stress and Strain and their types, Hook's law, longitudinal and lateral strain, Poisson's ratio, stress-strain diagram for ductile and brittle materials, extension of a bar due to without and with self weight, bar of uniform strength, stress in a bar, elastic constants and their significance, relation between elastic constants, Young's modulus of elasticity, modulus of rigidity and bulk modulus. Temperature stress and strain calculation due to axial load and variation of temperature 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 ellipse of stress and their applications. Generalized Hook's law, principal stresses related to principal strains.

Unit –II

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) Uniformity distributed loads over the whole span or part of span
c) Combination of concentrated and uniformly distributed load
d) Uniformly varying loads
e) Application of moments

Unit –III

Bending Stresses In Beams: Assumptions in the simple bending theory; derivation of formula and its application to beams of rectangular, circular and channel, I and T- sections. Combined direct and bending stresses in afore-mentioned sections, composite / flitched beams.

Unit –IV

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

Unit –V

Columns and struts: Introduction, failure of columns, Euler's formula, Rankine-Gordon's formula, Johnson's empirical formula for axially loaded columns and their applications.

Unit –VI

Slope and deflection: Relationship between moment, slope and deflection; method of integration, Macaulay's method, moment area method and use of these methods to calculate slope and deflection for the following:

a) Cantilevers

b) Simply supported beams with or without overhang

c) Under concentrated loads, uniformly distributed loads or combination of concentrated & uniformly distributed loads.

Suggested Readings / Books:

- D.S. Bedi, ***Strength of Materials,*** Khanna Book Publishing Company.
- E.P. Popov, ***Mechanics of Materials-(SI Version),*** Prentice Hall India.
- R.S Lehri and A.S. Lehri***, Strength of Materials,*** Kataria and Sons.
- S.S.Rattan, ***Strength of Materials,*** Tata McGraw Hill.
- Timoshenko and Young, ***Elements of Strength of Materials,*** East West Press (EWP).
- James M Gere and Barry J. Goodno, ***Strength of Materials,*** Cengage Learning.

BTME-302 Theory of Machines-I

Course Objective/s & Expected Outcome/s: 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 for different

applications. 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

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 (including Corliolis Components).

Unit –II

Lower and higher Pairs: Universal Joint, Calculation of maximum Torque, Steering Mechanisms including Ackerman and Davis approximate steering mechanism, Engine Indicator, Pentograph, Straight Line Mechanisms, Introduction to Higher Pairs With Examples

Unit –III

Belts, Ropes and Chains: Material & Types of belt, Flat and V-belts, Rope & Chain Drives, Idle Pulley, Intermediate or Counter Shaft Pulley, Angle and Right Angle Drive, Quarter Turn Drive, 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 including consideration of Creep and Slip, Centrifugal Tensions and its effect on power transmission.

Unit –IV

Cams: Types of cams and follower, definitions of terms connected 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). Analysis of follower motion for circular, convex and tangent cam profiles.

Unit –V

Friction Devices: Concepts of friction and wear related to bearing and clutches. 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).

Unit –VI

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 used for engines and punching machines.

Unit –VII

Governors: Function, types and characteristics of governors. Watt, Porter and Proell governors. Hartnell and Willson-Hartnell spring loaded governors. Numerical problems related to these governors. Sensitivity, stability, isochronisms and hunting of governors. Governor effort and power, controlling force curve, effect of sleeve friction.

Suggested Readings / Books:

- S. S. Rattan, Theory of Machines, Tata McGraw Hill, New Delhi.
- Jagdish Lal, Theory of Mechanisms & Machines, Metropolitan Book Co.
- Thomas Beven, Theory of Machines, Longman's Green & Co., London.
- W. G. Green, Theory of Machines, Blackie & Sons, London
- V.P. Singh, Theory of Machines Dhanpat Rai.

BTME-303 Machine Drawing

Course Objective/s and Expected Outcome/s: The objective of this course is to make students understand the principles and requirements of production drawings and learning how to assemble and disassemble important parts used in major mechanical engineering applications. After going through this course, the student shall be able to understand the drawings of mechanical components and their assemblies along with their utility for design of components

Unit –I

Introduction: Principles of Drawing, Requirements of production drawing, Sectioning and conventional representation, Dimensioning, symbols of standard tolerances, Machining Symbols, introduction and Familiarization of Code IS: 296

Unit –II

Fasteners: Various types of screw threads, types of nuts and bolts, screwed fasteners, welding joints and riveted joints

Unit –III

Assembly and Disassembly:

a) **Couplings:** Solid or Rigid Coupling, Protected Type Flange coupling, Pin type flexible coupling, muff coupling, Oldham, universal coupling, claw coupling, cone friction clutch, free hand sketch of single plate friction clutch.

b) Knuckle and cotter joints

c) **Pipe and Pipe Fittings:** flanged joints, spigot an socket joint, union joint, hydraulic an expansion joint

d) **IC Engine Parts:** Piston, connecting rod

e) **Boiler Mountings:** Steam stop valve, feed check valve, safety valve, blow off cock.

f) **Bearings:** Swivel bearing, thrust bearing, Plummer block, angular plumber block

g) **Miscellaneous:** Screw Jack, Drill Press Vice, Crane hook, Tool Post, Tail Stock, Drilling Jig.

NOTE:

I. *Drawing Practice is to be done as per code IS: 296.*

II. *First angle projection to be used. Drawings should contain bill of materials and should illustrate finish.*

III. *The syllabus given above indicates the broad outlines and the scope of the subject to be covered. It is not necessary to cover all the drawing exercises of the types of machine tools mentioned above.*

IV. *The University paper shall be having following structure / weighage:*

Section A *– Short type questions based upon whole syllabus- 30%*

Section B*- Free Hand sketching of machine parts etc.-20%*

Section C*- Assembly drawing of machine parts with at least two views -50%*

Suggested Readings / Books:

- Ajit Singh, Machine Drawing (including Auto CAD), Tata McGraw Hill.
- A Text Book of Machine Drawing by R. K. Dhawan, S. Chand and Co. Ltd.
- N.D. Bhatt, Machine Drawing, Charotar publications.
- N. Sidheshwar, Machine Drawing, Tata McGraw Hill.
- P.S. Gill, Machine Drawing, BD Kataria and Sons.
- V Lakshmi Narayanan and Mathur, Text-book of Machine Drawing.

BTME 304 Applied Thermodynamics-I

Course Objective/s and Expected Outcome/s: This course is designed for comprehensive study of combustion and thermal aspects in internal combustion engines, steam power plants and its allied components. This will enable the students to understand combustion phenomenon and thermal analysis of steam power plant components. The students will be able to identify, track and solve various combustion problems and evaluate theoretically the performance of various components involved in steam power plants and internal combustion engines.

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.

Unit –II

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; Pressure-time/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; Emissions from SI and CI Engines and methods to reduce/control them. Logarithmic plotting of PV-diagrams. High speed Engine Indicators.

Unit –III

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.

Unit –IV

Steam Generators - Definition: Classification and Applications of Steam Generators; Working and constructional details of fire-tube and water-tube boilers: (Cochran, Lancashire, Babcock and Wilcox boilers); Merits and demerits of fire-tube and water-tube boilers; Modern high pressure boilers (Benson boiler, La Mont boiler) and Super critical boilers (**Once through boilers-*Tower type***); Advantages of forced circulation; Description of boiler mountings and accessories: Different types of Safety Valves, Water level indicator, pressure gauge, Fusible plug, Feed pump, Feed Check Valve, Blow-off Cock, Steam Stop-Valve, Economiser, Super-heater; Air pre-heater and Steam accumulators; Boiler performance: equivalent evaporation, boiler efficiency, boiler trial and heat balance; Types of draught and Calculation of chimney height.

Unit –V

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.

Unit –VI

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 –VII

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;

Unit –VIII

De Laval Turbine: Compounding of impulse turbines: purpose, types and pressure and velocity variation, velocity diagrams/triangles, combined velocity diagram/triangle and calculations for force, axial thrust, work, power, blade efficiency, stage efficiency, overall efficiency and relative efficiency;

Unit –IX

Impulse-Reaction Turbine: pressure and velocity variation, velocity diagrams/triangles, 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; Economic assessment; Governing of steam turbines.

Unit –X

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; **Cooling towers:** function, types and their operation.

Suggested Readings / Books:

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

BTME 305 Manufacturing Processes –I

Course Objective/s and Outcome/s: This course is designed to provide students with an overview of a wide variety of manufacturing processes for processing of engineering materials. The students will learn principles, operations and capabilities of various metal casting and metal joining processes. They will also learn about the defects, their causes and remedies in these processes. Upon completion of the course, the students should have the ability to understand the importance of the manufacturing processes and to select a suitable metal casting and metal joining processes to fabricate an engineering product.

Unit –I

Introduction: Classification of manufacturing processes, selection criteria for manufacturing processes, general trends in manufacturing.

Unit –II

Casting Processes: Introduction to metal casting. patterns: types, materials and allowances. Moulding materials: moulding sand compositions and properties, sand testing, types of moulds, moulding machines. Cores: function, types, core making process, core-prints, chaplets. Elements of gating system and risers and their design. Design considerations of castings. Melting furnaces, cupola furnace, charge calculations, induction furnaces. Casting processes: sand casting, shell mould casting, investment casting, permanent mould casting, full mould casting, vacuum casting, die casting, centrifugal casting, and continuous casting. Metallurgical considerations in casting, Solidification of metals and alloys, directional solidification, segregation, nucleation and grain growth, critical size of nucleus. Cleaning and finishing of castings.

Unit –III

Welding Processes: Introduction and classification of welding processes, to welding processes, weldability, welding terminology, general principles, welding positions, and filler metals. Gas welding: principle and practice, oxy-acetylene welding equipment, oxy-hydrogen welding. Flame cutting. Electric arc welding: principle, equipment, relative merits of AC & DC arc welding. Welding processes: manual metal arc welding, MIG welding, TIG welding, plasma arc welding, submerged arc welding. Welding arc and its characteristics, arc stability, and arc blow. Thermal effects on weldment: heat affected zone, grain size and its control. Electrodes: types, selection, electrode coating ingredients and their function. Resistance welding: principle and their types i.e. spot, seam, projection, up-set and flash. Spot welding machine. Advanced welding processes: friction welding, friction stir welding, ultrasonic welding, laser beam welding, plasma arc welding, electron beam welding, atomic hydrogen welding, explosive welding, thermit welding, and electro slag welding. Considerations in weld joint design. Other joining processes: soldering, brazing, braze welding.

Unit –IV

Inspection and Testing: Casting defects, their causes and remedies. Welding defects, their causes and remedies. Destructive and non destructive testing: visual inspection, x-ray radiography,

magnetic particle inspection, dye penetrate test, ultrasonic inspection, eddy current testing, hardness testing, and micro hardness testing.

Suggested Readings / Books:

- A. Manna, A Textbook of Manufacturing Science and Technology, PHI Publishers.
- H.S. Shan, Manufacturing Processes, Vol.I. , Pearson Publishers.
- P. N. Rao, Manufacturing Technology, Foundry, Forming & Welding, Tata McGraw Hill.
- R.S. Parmar ,Welding Engineering & Technology, Khanna Publishers.
- Serope Kalpakjian and Steven R. Schmid, Manufacturing Engineering and Technology, Pearson Publishers.

BTME-306 Engineering Materials & Metallurgy

Course Objective/s and Outcome/s: This course is designed to develop fundamental concepts of crystallography, phase transformation and heat treatment processes. The students will learn the atomic structure of metals, imperfections, diffusion mechanisms and theories of plastic deformation. They will also understand equilibrium diagrams, time-temperature transformation curves and heat treatment processes. Upon completion of the course, the students will be able to understand the concepts of crystal structure, microstructure and deformation. They will also be able to understand the phase diagrams which are useful for design and control of heat treating processes.

Unit –I

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

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

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

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.

Suggested Readings / Books:

- B. Zakharov, Heat Treatment of Metals, University Press.
- T. Goel and R.S. Walia, Engineering Materials & Metallurgy.
- Sidney H Avner, Introduction to Physical Metallurgy, Tata Mcgraw-Hill.
- V. Raghavan, Physical Metallurgy: Principles and Practice, PHI Learning.
- Y. Lakhin , Engineering Physical Metallurgy, Mir Publishers.

BTME-307 Engineering Materials & Metallurgy Lab

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 hardenabilty of steel by Jominy End Quench Test.

BTME-308 Strength of Materials Lab

1. To perform tensile test in ductile and brittle materials and to draw stress-strain curve and to determine various mechanical properties.
2. To perform compression test on Cast Iron.
3. To perform any one hardness tests (Rockwell, Brinell & Vicker's test).
4. To perform impact test to determine impact strength.
5. To perform torsion test and to determine various mechanical properties.
6. To perform Fatigue test on circular test piece.
7. To perform bending test on beam and to determine the Young's modulus and modulus of rupture.
8. Determination of Bucking loads of long columns with different end conditions.

9. To evaluate the stiffness and modulus of rigidity of helical coil spring.

BTME 309 Applied Thermodynamics Lab.

1. Study of construction and operation of 2 stroke and 4 stroke Petrol and Diesel engines using actual engines or models.
2. To plot actual valve timing diagram of a 4 stroke petrol and diesel engines and study its impact on the performance of engine.
3. Study of working, construction, mountings and accessories of various types of boilers.
4. To perform a boiler trial to estimate equivalent evaporation and efficiency of a fire tube/ water tube boiler.
5. Determination of dryness fraction of steam and estimation of brake power, Rankine efficiency, relative efficiency, generator efficiency, and overall efficiency of an impulse steam turbine and to plot a Willian's line.
6. Determine the brake power, indicated power, friction power and mechanical efficiency of a multi cylinder petrol engine running at constant speed (Morse Test).
7. Performance testing of a diesel engine from no load to full load (at constant speed) for a single cylinder/ multi- cylinder engine in terms of brake power, indicated power, mechanical efficiency and specific fuel consumption and to measure the smoke density. Draw/obtain power consumption and exhaust emission curves. Also make the heat balance sheet.
8. Performance testing of a petrol engine from no load to full load (at constant speed) for a single cylinder/ multi- cylinder engine in terms of brake power, indicated power, mechanical efficiency and specific fuel consumption and to measure the exhaust emissions. Also draw/obtain power consumption and exhaust emission curves.
9. Study of construction and operation of various types of steam condensers and cooling towers.

Fourth Semester

BTME 401 Strength of Materials-II

Course Objective/s and Outcome/s: 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 cross sections; stresses in helical, spiral and leaf springs; stress and strain analysis of thin, thick cylinder and spheres subjected to internal pressure; and various failure theories. The outcome of the course is to enhance deep and vigorous understanding of stress analysis in various machine elements, so that a student can properly analyze and design a mechanical member from the strength point of view under various conditions.

Unit –I

Strain energy: Introduction to strain energy, energy of dilation and distortion. Resilience, stress due to suddenly applied loads. Castigliano's and Maxwell's theorem of reciprocal deflection.

Unit –II

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 to problems related to two dimensional stress systems.

Unit –III

Springs: Open and closed coiled helical springs under the action of axial load and/or couple. Flat spiral springs- derivation of formula for strain energy, maximum stress and rotation. Leaf spring- deflection and bending stresses

Unit –IV

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

Unit –V

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, hub shrunk on solid shafts, shrinkage allowance and shrinkage stress.

Unit –VI

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

Unit –VII

Shear stresses in beams: Shear stress distribution in rectangular, circular, I, T and channel section; built up beams. Shear centre and its importance.

Unit –VIII

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

Suggested Readings / Books:

- D.S. Bedi, Strength of materials, Khanna book publishing company.
- G.H. Ryder, Strength of materials, Macmillan India Ltd.
- R.S Lehri and A.S. Lehri, Strength of materials, vol. 2, S. K. Kataria and Sons.
- S.S.Rattan, Strength of materials, Tata McGraw Hills.
- Timoshenko and Gere, Mechanics of materials, CBS publishers.

BTME 402 Theory of Machines – II

Course Objective/s & Outcome/s: 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

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

Unit –II

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 –III

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 –IV

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 involute rack, helical, spiral, bevel and worm gears. Center distance for spiral gears and efficiency of spiral gears

Unit –V

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 –VI

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.

Unit –VII

Kinematic synthesis of Mechanism: Freudenstien equation, Function generation errors in synthesis, two and three point synthesis, Transmission angles, least square techniques.

Suggested Readings / Books:

- S.S. Rattan, Theory of Machines, Tata Mc. Graw Hill.
- John, Gordon, and Joseph, Theory of Machines and Mechanisms, Oxford University Press.
- Hams Crone and Roggers, Theory of Machines.
- Shigley, Theory of Machines, Mc Graw Hill.
- V.P. Singh, Theory of Machines, Dhanpat Rai and Sons.

BTME 403 Fluid Mechanics

Course Objective/s and Expected Outcome/s: This course is designed for the undergraduate mechanical engineering students to develop an understanding of the behavior of fluids at rest or in motion and the subsequent effects of the fluids on the boundaries as the mechanical engineers has to deal with fluids in various applications. This course will also develop analytical abilities related to fluid flow. It is expected that students will be able to have conceptual understanding of fluids and their properties, apply the analytical tools to solve different types of problems related to fluid flow

in pipes, design the experiments effectively and do the prototype studies of different types of machines and phenomenon.

Unit –I

Fundamentals of Fluid Mechanics: Introduction; Applications; Concept of fluid; Difference between solids, liquids and gases; Concept of continuum; Ideal and real fluids; Fluid properties: density, specific volume, specific weight, specific gravity, viscosity (dynamic and kinematic), vapour pressure, compressibility, bulk modulus, Mach number, surface tension and capillarity; Newtonian and non-Newtonian fluids.

Unit –II

Fluid Statics: Concept of static fluid pressure; Pascal's law and its engineering applications; Hydrostatic paradox; Action of fluid pressure on a plane submerged surface (horizontal, vertical and inclined): resultant force and centre 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; Pressure distribution in a liquid subjected to : (i) constant acceleration along horizontal, vertical and inclined direction (linear motion), (ii) constant rotation.

Unit –III

Fluid Kinematics: Classification of fluid flows; Lagrangian and Euler flow descriptions; Velocity and acceleration of fluid particle; Local and convective acceleration; Normal and tangential acceleration; Path line, streak line, streamline and timelines; Flow rate and discharge mean velocity; One dimensional continuity equation; Continuity equation in Cartesian (x,y,z), polar (r,θ) and cylindrical (r,θ,z) coordinates; Derivation of continuity equation using the Lagrangian method in Cartesian coordinates; Rotational flows: rotation, vorticity and circulation; Stream function and velocity potential function, and relationship between them; Flow net.

Unit –IV

Fluid Dynamics: Derivation of Euler's equation of motion in Cartesian coordinates, and along a streamline; Derivation of Bernoulli's equation (using principle of conservation of energy and equation of motion) and its applications to steady state ideal and real fluid flows; Representation of energy changes in fluid system (hydraulic and energy gradient lines); Impulse momentum equation;

Kinetic energy and momentum correction factors; Flow along a curved streamline; Free and forced vortex motions.

Unit –V

Dimensional Analysis and Similitude: Need of dimensional analysis; Fundamental and derived units; Dimensions and dimensional homogeneity; Rayleigh's and Buckingham's π - method for dimensional analysis; Dimensionless numbers (Reynolds, Froudes, Euler, Mach, and Weber) and their significance; Need of similitude; Geometric, kinematic and dynamic similarity; Model and prototype studies; Similarity model laws.

Unit –VI

Internal Flows: Laminar and Turbulent Flows: Reynolds number, critical velocity, critical Reynolds number, hydraulic diameter, flow regimes; Hagen – Poiseuille equation; Darcy equation; Head losses in pipes and pipe fittings; Flow through pipes in series and parallel; Concept of equivalent pipe; Roughness in pipes, Moody's chart.

Unit –VII

Pressure and Flow Measurement: Manometers; Pitot tubes; Various hydraulic coefficients; Orifice meters; Venturi meters; Borda mouthpieces; Notches (rectangular, V and Trapezoidal) and weirs; Rotameters.

Suggested Readings / Books:

- D.S. Kumar, Fluid Mechanics and Fluid Power Engineering, S.K. Kataria and Sons Publishers.
- S.K. Som, G. Biswas and S. Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill.
- C.S.P. Ojha, R. Berndtsson and P.N. Chandramouli, Fluid Mechanics and Machinery, Oxford University Press.
- Y.A. Cengel and J.M. Cimbala, Fluid Mechanics - Fundamentals and Applications, Tata McGraw Hill.
- B.R. Munson, D.F. Young, T.H. Okiishi and W.W. Huebsch, Fundamentals of Fluid Mechanics, John Wiley and Sons.
- J.F. Douglas and J.M. Gasiorek, J.A. Swaffield and L.B. Jack, Fluid Mechanics, Pearson.
- V.L. Streeter, E.B. Wylie and K.W. Bedford, Fluid Mechanics, Tata McGraw Hill.

BTME 404 Applied Thermodynamics-II

Course Objectives and Expected Outcomes: This course is designed for providing comprehensive understanding and thermodynamic analysis of positive displacement air compressors and thermal turbo machines used in power generation, aircraft, spacecraft and rocket propulsion. The students will be able to understand the thermodynamic working as well as performance of thermal turbo power machinery. They will also be able to select various thermal devices required for aforesaid applications.

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.

Unit –II

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 –III

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.

Unit –IV

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 –V

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.

Unit –VI

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 –VII

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; Dual Turbine system; Series and parallel arrangements; Closed and Semi-closed gas turbine cycle; Requirements of a gas turbine combustion chamber; Blade materials and selection criteria for these materials and requirements of blade materials; Gas turbine fuels.

Unit –VIII

Jet Propulsion Principle of jet propulsion; 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 c onsumption**;** Rocket propulsion, its thrust and thrust power; Propulsion and overall thermal efficiency; Types of rocket motors (e.g. solid propellant and liquid propellant systems); Various common propellant combinations (i.e. fuels) used in rocket motors; Cooling of rockets; 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.

Suggested Readings / Books:

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

BTME 405 Manufacturing Processes-II

Course Objective/s and Outcome/s: This course is designed to make students learn principles, operations and capabilities of various metal machining and metal forming processes. They will understand the importance of process variables controlling these processes. They will also recognize the inter-relationships between material properties and manufacturing processes. Upon completion of the course, the students should have the ability to select different types of the metal machining and forming processes needed for the manufacturing of various geometrical shapes of products.

Unit –I

Metal Forming: Introduction and classification. Rolling process: introduction, classification, rolling mills, products of rolling, rolling defects and remedies. Forging: open and closed die forging, forging operations, hammer forging, press forging and drop forging, forging defects, their causes and remedies. Extrusion: classification, equipment, defects and remedies. Drawing: drawing of rods, wires and tubes, draw benches, drawing defects and remedies. Sheet metal forming operations: piercing, blanking, embossing, squeezing, coining, bending, drawing and deep drawing, and spinning. Punch and die set up. Press working: press types, operations, press tools, progressive and combination dies. Process variables and numerical problems related to load calculation in Rolling, Forging, Extrusion, Drawing and Sheet metal forming. High velocity forming of metals: introduction, electro-hydraulic forming, mechanical high velocity forming, magnetic pulse forming and explosive forming. **Powder Metallurgy:** Introduction, advantages, limitations, and applications methods of producing metal powders, briquetting and sintering.

Unit –II

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, Fundamentals of measurement of cutting forces and chip tool interface temperature. 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. Selection of machining parameters. Coolants and lubricants: classification, purpose, function and properties.

Unit III

Machine Tools Lathe: classification, description and operations, kinematic scheme of lathe, and lathe attachments. Shaping and planing machine: classification, description and operations, drive mechanisms. Milling machine: classification, description and operations, indexing devices, up milling and down milling. Drilling machine: classification, description and operations. Boring machine: classification, description and operations. Grinding machines: classification, description and operations, wheel selection, grinding wheel composition and nomenclature of grinding wheels, dressing and truing of grinding wheels. Broaching machine: classification, description and operations. Speed, feed and machining time calculations of all the above machines.

Suggested Readings / Books:

- B. L. Juneja and G. S. Sekhon, Fundamentals of Metal Cutting & Machine Tools, New Age International (P) Ltd.
- H.S. Shan, Manufacturing Processes, Vol. I&II, , Pearson Publishers
- PC Sharma, A Text Book of Production Technology, S. Chand & Company Ltd.
- M. P. Groover, Fundamentals of Modern manufacturing, Wiley
- Serope Kalpakjian and Steven R. Schmid, Manufacturing Engineering and Technology, Pearson Publishers.

BTME 406 Fluid Mechanics LAB

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 or 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.
9. To determine the velocity distribution for pipeline flow with a pitot static probe.
10. Experimental evaluation of free and forced vortex flow.

BTME 407 Manufacturing Processes Lab

Casting:

1. To determine clay content, moisture content, hardness of a moulding sand sample.
2. To determine shatter index of a moulding sand sample.
3. To test tensile, compressive, transverse strength of moulding sand in green condition.
4. To determine permeability and grain fineness number of a moulding sand sample.

Welding:

1. To make lap joint, butt joint and T- joints with oxy- acetylene gas welding and manual arc welding processes
2. To study MIG, TIG and Spot welding equipment and make weld joints by these processes.

Machining and Forming

1. To study constructional features of following machines through drawings/ sketches:
    a. Grinding machines (Surface, Cylindrical)
    b. Hydraulic Press

c. Draw Bench
d. Drawing and Extrusion Dies
e. Rolling Mills

2. To grind single point and multipoint cutting tools
3. To prepare job on Lathe involving specified tolerances; cutting of V- threads and square threads.
4. To prepare job on shaper involving plane surface,
5. Use of milling machines for generation of plane surfaces, spur gears and helical gears; use of end mill cutters.
6. To determine cutting forces with dynamometer for turning, drilling and milling operations.

Note: At least one industrial visit must be arranged for the students for the live demonstration of Casting, Welding, Forming and Machining processes.

BTME 408 Theory of Machines Lab

1. To draw displacement, velocity & acceleration diagram of slider - crank and four bar mechanism.
2. To study the various inversions of kinematic chains.
3. Conduct experiments on various types of governors and draw graphs between height and equilibrium speed of a governor.
4. Determination of gyroscopic couple (graphical method).
5. Balancing of rotating masses (graphical method).
6. Cam profile analysis (graphical method)
7. Determination of gear- train value of compound gear trains and epicyclic gear trains.
8. To draw circumferential and axial pressure profile in a full journal bearing.
9. To determine coefficient of friction for a belt-pulley material combination.
10. Determination of moment of inertia of flywheel.

BTAM-500 MATHEMATICS-III

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

Detailed Contents

1. Fourier Series Periodic functions, Euler's formula. Even and odd functions, Change of Interval, half range expansions, Fourier series of different wave forms.

2. Laplace Transforms: Definition, Laplace transforms of various standard functions, properties of Laplace transforms, inverse Laplace transforms, transform of derivatives and integrals, Transform of multiplication and division by t, convolution theorem, Laplace transform of unit step function. Applications to solution of ordinary linear differential equations with constant coefficients.

3. Special Functions: Frobenius method for power series solution of differential equations, Bessel's equation, Bessel functions of the first and second kind, Legendre's equation, Legendre polynomial.

4. Partial Differential Equations: Formation of partial differential equations, Equations solvable by direct integration, Linear partial differential equations, homogeneous partial differential equations with constant coefficients. Solution by method of separation of variables, Applications: Wave equation and Heat conduction equation in one dimension. Solution of two dimensional Laplace equation (Cartesian co- ordinates).

5. Functions of Complex Variable: definition of Limit, continuity, derivative of complex functions, and analytic function. Necessary and sufficient conditions for analytic function (without proof), Cauchy-Riemann equation (Cartesian and polar co-ordinates), harmonic functions, orthogonal system, determination of conjugate functions. Miller's Thosmson method, Applications to fluid flow problems. Brief introduction to basic transformations, Bilinear transformations, complex integration: Line integrals in the complex plane, Cauchy's integral theorem, Cauchy's integral formula for analytic function and its derivatives. Taylor's and Laurent's expansions, singular points, poles, residue, Cauchy's Residue theorem, evaluation of real integrals by contour integration (F(*cosx, sinx*)

Books

1. Kreyszing Erwin, Advanced Engineering Mathematics, Wiley Eastern

2. B.S Grewal, Higher Engineering Mathematics, Khanna Publishers

3. N.K Jain, Numerical Solutions of Differential Equations, Prentice Hall

4. Sharma and Gupta, Differential Equations, Krishna Prakashan Media

5. N.P Bali , Text book of Eng Mathematics, Laxmi Publishers

BTME 501 MACHINE DESIGN-I

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

Detailed Contents

1. Meaning of design with special reference to machine design, definition and understanding of various types of design, design process, design and creativity, general design considerations, concept of tearing, bearing, shearing, crushing, bending and fracture.
2. Designation of materials according to Indian standards code, basic criteria of selection of material, mechanical properties of materials.
3. Concept of concurrent engineering in design, introduction to 'Design for X' manufacturing considerations in machine design, stress concentration, factor of safety under different loading conditions, design for static loading, design for variable loading for both limited and unlimited life, concept of fatigue and endurance strength.
4. Design of fasteners:
   Design of rivets for boiler joints, lozenge joints, eccentrically loaded joints.
   Design of spigot and socket cotter joint, gib and cotter joint and knuckle joint.
   Design of welded joints for various loading conditions in torsion, shear or direct loads, eccentrically loaded joints
5. Design of shaft and axles:
   Design of solid and hollow shafts for transmission of torque, bending moments and axial forces, Design of shaft for rigidity, Design of axle.
6. Design of keys and couplings:
   Design of keys, design of splines, design of sleeve and solid muff coupling, clamp or compression coupling, rigid and flexible flange coupling, design of universal joint.
7. Design of levers and links:
   Design of levers(foot lever, hand lever, cranked lever, bell crank lever, safety valve lever and shoe brake lever), design of link.
8. Design of pipe joints:
   Stresses in pipe joints, design of pipe joints with oval flange, square flange, design of seals and gaskets.

Books

1. Joseph E. Shigley, Charles Russell Mischke, Richard Gordon Budynas, Mechanical Engineering Design, McGraw-Hill
2. Robert C. Juvinall Fundamentals of machine component design, Wiley
3. V.K Jadon, Analysis and design of machine elements, I.K. International
4. V.B Bhandari, Design of Machine elements, Tata Mc. Hill
5. S.S Jolly, Design of machine elements-I, Dhanpat Rai and Co.

Following is a sample list of problems which may be used for Tutorials

1. Select a daily use product and design the conceptual design by applying the design process talking the controlling parameters

2. Make a list of mechanical components and know their materials and suggest some alternative materials for the each one of them

3. Design a wall bracket, which is being used in real life by actual measurement of load

a) Welded joints

b) Riveted and bolted joints

And justify your findings

4. Find a flange coupling in the college laboratory and justify its design by actual measurements

5. Design a shaft used in some practical application, by actual working and loading conditions

6. Select a braking system lever (both hand and foot lever) and justify the design parameters

7. Justify the design of single plate clutch of an engine assembly

Note: 1. Design data book compiled by PSG college of Engg. & Tech., Coimbatore is allowed in Examination.

Note: 2 Guide lines regarding paper setting:

Part A- 10 questions of 2 marks each. All compulsory.

Part B- There will be 6 questions of 10 marks each. Candidate will be required to attempt any four questions.

BTME 502 COMPUTER AIDED DESIGN AND MANUFACTURING

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

Detailed Contents

1. 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.

2. Geometric Transformations:

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

3. 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.

4. 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.

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

6. 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.

7. Group Technology (GT):

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

8. Computer Aided Process Planning:

Introduction and benefits of CAPP. Types of CAPP systems, machinability, data selection systems in CAPP.

9. 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.

Books:

1. Mikell P. Groover, 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

BTME 503 MECHANCIAL MEASUREMENTS AND METROLOGY

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

1. General Concepts

Need and classification of measurements and instruments; basic and auxiliary functional elements of a measurement system; Mechanical versus electrical / electronic instruments; primary, secondary and working standards.

2. Static and Dynamic Characteristics of Instruments

Range and span, accuracy and precision, calibration, hysteresis and dead zone, sensitivity and linearity, threshold and resolution; speed of response, lag, fidelity and dynamic error, dead time and dead zone. Zero, first and second order systems and their response to step, ramp and sinusoidal input signals.

3. Errors in Measurement

Sources of errors, systematic and random errors; statistical analysis of test-data, probable error and probability tables, rejection of test data, error propagation; Design and planning of experiments and report writing.

4. Metrology

Line, end and wavelength standards; linear measurements - vernier scale and micrometer, vernier height gauge and depth guage; comparators - their types, relative merits and limitations; Angular measurements - sine bar, clinometer, angle guage; concept and measurement of straightness and flatness by interferometry; surface 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.

5. Functional Elements

Introduction to sensors and transducers, types of sensors, review of electro-mechanical sensors and transducers - variable resistance, inductance and capacitive pick ups, photo cells and piezo-electric transducers and application of these elements for measurement of position / displacement, speed / velocity / acceleration, force and liquid level. Resistance strain guages, guage factor, bonded and unbonded guages, surface preparation and bonding technique signal conditioning and bridge circuits, temperature compensation, application of strain guages for direct, bending and torsional loads. Introduction to amplifying, transmitting and recording devices.

6. Pressure and Flow Measurement

Bourdon tube, diaphragm and bellows, vacuum measurement - Mcleod guage, thermal conductivity guage and ionisation guage; Dead weight guage tester. Electromagnetic flux meters, ultra-sonic flow meters and hot wire anemometer: flow visualisation techniques.

7. Temperature Measurement

Thermal expansion methods - bimetallic thermometers, liquid-in-glass thermeter and filled-in-system thermometers; thermo-electric sensors - common thermo couples, reference junction considerations, special materials and configurations; metal resistance thermometers and thermistors; optical and total radiation pyrometers; calibration standards.

8. 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 dynamo meters.

Books

1. E.O Doebelin, Measurement System: Application and Design, McGraw Hill

2. J.P Holman, Experimental Methods for Engineers, McGraw Hill

3. D.S Kumar, Mechanical Measurement and Control, Metropolitan Book Co.

4. R.K Jain, Engineering Metrology, Khanna Publishers

5. B.C Kuo, Automatic Control systems, Prentice Hall

BTME 504 INDUSTRIAL AUTOMATION AND ROBOTICS

Internal Marks: 40 External Marks: 60 Total Marks: 100

Detailed Contents

1. Introduction:
   - Concept and scope of automation:
   - Socio economic impacts of automation
   - Types of Automation, Low Cost Automation
2. 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:
3. 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
   - Troubleshooting and “Causes & Effects of Malfunctions”
   - Basics of Control Chain
   - Circuit Layouts
   - Designation of specific Elements in a Circuit
4. Fluidics:
   - Boolean algebra
   - Truth Tables
   - Logic Gates
   - Coanda effect
5. Electrical and Electronic Controls
   - Basics of Programmable logic controllers (PLC)
   - Architecture & Components of PLC
   - Ladder Logic Diagrams
6. Transfer Devices and feeders:
   - Classification, Constructional details and Applications of
   - Transfer devices
   - Vibratory bowl feeders
   - Reciprocating tube
   - Centrifugal hopper feeders
7. 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

Books

1. Anthony Esposito, Fluid Power with applications, Pearson
2. S. R Majumdar, Pneumatic Control, McGraw Hill
3. S. R Deb, Robotic Technology and Flexible Automation, Tata Mc Hill
4. Saeed B. Niku Introduction to Robotics, Wiley India
5. Ashitava Ghosal, Robotics, Oxford

BTME 505 AUTOMOBILE ENGINEERING

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

1. Introduction

Basic structure, general layout and type of automotive vehicles, Frameless and unitary construction; position of power unit.

2. 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

3. 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

4. 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.

5. 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

6. 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

7. 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

8. Braking System

General braking requirements; Mechanical, hydraulic, vacuum power and servo brakes; Weight transfer during braking and stopping distances

9. 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

10. Maintenance

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

Books

1. W.H Crouse, Automotive mechanics, McGraw Hill

2. J. Heitner, Automotive Mechanics, East West Press

3. Kirpal Singh, Automobile Engineering Vol. I and II, Standard Publishers

4. J. Webster, Auto Mechanics, Glencoe Publishing Co.

5. P.S Gill, Automobile Engineering, S.K Kataria

BTME506 COMPUTER AIDED DESIGN AND MANUFACTURING LAB

Internal Marks: 30 **External Marks: 20** **Total Marks: 50**

1. Introduction to modeling (using any CAD software):

1. 2D drawing using sketcher – 2 Drawings 2 Hrs

2. 3D modeling using 3D features (Modeling of Crane Hook, Bench Vice, Screw Jack components) 4 Hrs

3. Assembling and drafting (any 2 above mentioned assemblies) with proper mating conditions and interference checking. 4 Hrs

4. Surface modeling – (Computer mouse, Plastic bottles with spraying Nozzle) 4 Hrs

2. Computer Aided Manufacturing:

1. Manual part programming on CNC Lathe and CNC Milling – (4 programs, 2 for each) 4 hrs

2. Computer Aided Part programming for CNC Lathe and CNC Milling to generate tool path, NC code, and Optimization of tool path (to reduce machining time) using any CAM software. 4Hrs

BTME 507 MECHANICAL MEASUREMENTS AND METROLOGY LAB

Internal Marks: 30 **External Marks: 20** **Total Marks: 50**

1. Measurement of an angle with the help of sine bar
2. Measurement of surface roughness of a machined Plate, Rod and Pipe
3. Measurement of gear elements using profile projector
4. Measurement of effective diameter of external threads using Three wire method
5. Measurement of thread element by Tool makers microscope
6. Calibration of a pressure guage with the help of a dead weight guage tester
7. Use of stroboscope for measurement of speed of shaft
8. Use of pitot tube to plot velocity profile of a fluid through a circular duct
9. Preparation of a thermocouple, its calibration and application for temperature measurement

BTME 508 INDUSTRIAL AUTOMATION AND ROBOTICS LAB

Internal Marks: 15 **External Marks: 10** **Total Marks: 25**

1. Design and assembly of hydraulic / pneumatic circuit.

2. Demonstration and working of power steering mechanism

3. Study of reciprocating movement of double acting cylinder using pneumatic direction control valves

4. Use of direction control valve and pressure control valves clamping devices for jig and fixture

5. Study of robotic arm and its configuration

6. Study the robotic end effectors

7. Study of different types of hydraulic and pneumatic valves

BTME 509 AUTOMOBILE ENGINEERING LAB

Internal Marks: 15 **External Marks: 10** **Total Marks: 25**

1. Valve refacing and valve seat grinding and checking for leakage of valves

2. Trouble shooting in cooling system of an automotive vehicle

3. Trouble shooting in the ignition system, setting of contact breaker points and spark plug gap

4. Demonstration of steering system and measurement of steering geometry angles and their impact on vehicle performance.

5. 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.

6. Fault diagnosis in transmission system including clutches, gear box assembly and differential.

7. Replacing of ring and studying the method of replacing piston after

6th Semester

BTME 601 DESIGN OF MACHINE ELEMENTS -II

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

1. Transmission Drives

Belt and rope drives: Basics, Characteristics of belt drives, selection of flat belt, Design of Flat belt, V-belt and rope (steel wire), Design of the pulley for the same

Chain Drives: Basics, Roller chains, polygonal effect, power rating, selection of chain

Gear drives: Standard system of gear tooth and gear module, gear tooth failure, strength of gear tooth, terminology of spur, helical, bevel, worm and worm wheel, Design of spur, helical, straight bevel gears, worm and worm wheel

2. Bearings

Slider: Principle of hydrodynamic lubrication, modes of lubrication, Reynolds equation, bearing performance parameters, slider bearing design

Roller: Types, selection guidelines, static and dynamic load carrying capacity, Stribeck's equation, equivalent bearing load, load life relationship, selection of bearing, comparison of roller and slider bearing

3. Design of Flywheel

Introduction, Energy stored in a flywheel, stresses in a rim, design considerations

4. Springs

Types; end styles of helical compression spring; stress and deflection equation; surge in spring; nipping of leaf spring; Design of close-coil helical spring and multi leaf spring

5. Clutches

Design of contact clutches i.e. plate, multi-disc, cone and centrifugal clutches.

6. Brakes

Design of band, disc, block with shoe and internal expanding brakes.

Books

a. Joseph E. Shigley, Charles Russell Mischke, Richard Gordon Budynas, Mechanical Engineering Design, McGraw-Hill

b. Robert C. Juvinall Fundamentals of machine component design, JohnWiley Eastern
c. V.K Jadon, Analysis and design of machine elements, I.K. International
d. V.B Bhandari, Design of Machine elements, Tata Mc-Graw. Hill
e. S.S Jolly, Design of machine elements-II, Dhanpat Rai and Co.

Following is the list of sample tutorial problems for design practice to be given to the students:

1. Find an assembly containing the belt and pulley mechanism and do the complete design calculations and then justify the existing design.

2. Design a transmission system involving the chain drives / gear drives by specifying inputs, and then justify design.

3. Design completely a hydrodynamic journal bearing and specify its suitability by using heat balance equation.

4. Select a suitable roller bearing for a particular application.

5. Design flywheel for industrial application and suggest its suitability.

6. Design springs for automobile application by specifying conditions and constraints.

7. Design a clutch and brakes of an automobile and justify its suitability.

Note:1 Design data book compiled by PSG college of Engg. & Tech., Coimbatore is allowed in examination.

Note: 2 Guide lines regarding paper setting:

Part A- 10 questions of 2 marks each. All compulsory.

Part B- There will be 6 questions of 10 marks each. Candidate will be required to attempt any four questions.

BTME-602 HEAT TRANSFER

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

1. 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.

2. Conduction:

Fouier'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 and spherical shells (simple and composite), 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, through under-ground electrical cables/Hot fluid pipes etc and case of nuclear fuel rod with and without cladding. Introduction to unsteady heat transfer, Newtonian heating and cooling of solids; definition and explanation of the term thermal diffusivity. Numerical.

3. 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. 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. Numerical.

4. Convection:

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). 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. Numerical.

Newton's law of cooling. Overall coefficient of heat transfer. 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); Numerical.

5. 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, Numerical.

6. Radiation:

Process of heat flow due to radiation, definition of emissivity, absorptivity, reflectivity and transmissivity. Concept of black and grey bodies, Plank's law of nonchromatic radiation. Kirchoff's law and Stefan Boltzman's law. Interchange factor. Lambert's Cosine law and the geometric factor. 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 bodies (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. Error in Temperature measurement by a thermocouple probe due to radiation losses.

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, SK Kataria & Sons (6^{th}/7^{th} Edition)
4. A.J. Chapman, Heat Transfer, McGraw Hill Book Company, New York.
5. J.P. Holman, Heat Transfer, Tata McGraw-Hill Publishing Company Ltd.(Special Indian Edition).
6. Yunus A.Cengel, Heat and Mass Transfer, Tata McGraw Hills Education Private Ltd (Special Indian Edition).
7. Eckert & Drake, Heat and Mass Transfer, McGraw Hill Book Company, New York.

BTME 603 FLUID MACHINERY

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

1. General Concepts:

Impulse momentum principle; jet impingement on stationary and moving flat plates, and on stationary or moving vanes with jet striking at the centre 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.

2. 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

3. 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

4. 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.

5. Similarity Relations and Performance Characteristics:

Unit quantities, specific speed and model relationships, scale effect; cavitation and Thoma's cavitation number; Concept of Net Positive Suction Head (NPSH) and its application in determining turbine / pump setting

6. 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

7. Hydraulic Devices and Systems:

Const., 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

Books:

1. R.L. Daughaty, Hydraulic Turbines, McGraw Hill

2. Jagdish Lal, Hydraulic Machines by Metropolitan Book Co

3. D.S. Kumar, Fluid Mechanics and Fluid Power Engineering, SK Kataria and Sons,

4. K. Subramaniam, Hydraulic Machines, Tata Mc Graw Hill

5. R.K. Purohit., Hydraulic Machines, Scientific Publishers

BTME-604 STATISTICAL AND NUMERICAL METHODS

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

1. Data, its Arrangements and Measures:

Introduction: Data, Data Array; Frequency Distribution Construction and Graphic representation. Mean, median, mode and standard deviation.

2. Probability and Probability Distributions:

Introduction: Definition probability and Probability Distribution; Conditional probability; Random variables, Poisson, Normal and Binomial distributions.

3. Sampling and Sampling Distributions:

Introduction: Fundamentals of Sampling, Large samples, small samples; Normal sampling distributions; Sampling distribution of the means, t-Distribution, F-Distribution, Chi-square Distribution.

4. Errors in Numerical Calculations:

Errors and their analysis, general error formula, errors in a series approximation

5. Solution of Algebraic and Transcendental Equations:

Bisection method, iteration method, Method of false position,, Newton -Raphson method, solution of systems of non linear equations.

6. Interpolation Method:

Finite difference, forward, backward and central difference, Difference of polynomial, Newton's formulae for interpolation, central difference interpolation formulae, Interpolation with unevenly spaced points, Newton's general interpolation formula, interpolation by iteration.

7. Numerical Differentiation and Integration:

Numerical differentiation, maximum and minimum values of a tabulated function; Numerical Integration-trapezoidal rule, Simpson1/3 rule, Simpsons 3/8 rule, Newton-cots integration formulae; Euler-Meclaurin formula, Gaussian integration(One dimensional only)

8. Solution of Linear Systems of Equations:

Gauss Elimination method (fall and banded symmetric and unsymmetric systems), Gauss Jordon method. Eigen value problems (Power method only).

9. Numerical solution of ordinary and partial differential equations:

Solution by Taylor's series, Prediction -correction method, Boundary value problems, Prediction corrector method, Euler's and modified Euler's method, Runge-Kutta method, finite difference methods. Finite difference approximation to derivatives, Solution to Laplaces equation- Jacobi's method, Gauss -Siedel method.

Note: The students are required to develop computer programs (using any high level language) for different Numerical Methods as part of assignment work.

Books:

1. S. S. Sastry, Introductory methods of numerical analysis by: Prentice Hall of India

2. V. RajaRaman, Computer Oriented Numerical Methods-

3. S.D. Conte, Cari De Boor, Elementary Numerical Analysis, Mc Graw Hill.

4. B. Cornahn, Applied Numerical Methods, John Wiley.

5. Richard I. Levin, S. David., Rubin Statistics for Management, Pearson.

BTME 605 HEAT TRANSFER LAB.

Internal Marks: 30 **External Marks: 20** **Total Marks: 50**

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 solid insulating material by slab method

   - powder materials by concentric spheres method / or by some transient heat transfer technique

   - a metal by comparison with another metal by employing two bars when kept in series and / or in parallel under different boundary conditions

   - Liquids by employing thin layer

2. Determination of coefficient of heat transfer for free/forced convection from the surface of a cylinder / plate when kept:

   a) along the direction of flow

   b) perpendicular to the direction of flow

   c) 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

   i) film condensation ii) drop-wise condensation

5. Determination heat transfer coefficient by radiation and hence find the Stefan Boltzman'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.

BTME 606 FLUID MACHINERY LAB

Internal Marks: 30 **External Marks: 20** **Total Marks: 50**

1. Determination of various efficiencies of Hydraulic Ram

2. To draw characteristics of Francis turbine/Kaplan Turbine

3. To study the constructional features of reciprocating pump and to perform test on it for determination of pump performance

4. To draw the characteristics of Pelton Turbine

5. To draw the various characteristics of Centrifugal pump

6. Determine the effect of vane shape and vane angle on the performance of centrifugal fan/Blower

7. A visit to any Hydroelectric Power Station

7th /8th semester

BTME 801 INDUSTRIAL ENGINEERING & MANAGEMENT

1. Introduction:

Definition and scope of industrial engineering,–Functions of industrial engineering department and its organization, Qualities of an industrial engineer, concept of production and productivity.

2. Concepts of Management:

Functions of Management, Evolution of Management Thought : Taylor's Scientific Management, Fayol's Principles of Management, Douglas Mc-Gregor's Theory X and Theory Y, Mayo's Hawthorne Experiments, Hertzberg's Two Factor Theory of Motivation, Maslow's Hierarchy of Human Needs – Systems Approach to Management.

3. Designing Organizational Structures:

Concept, Importance and characteristics of organization, Types of organization - Project, matrix and informal organization. Span of control, Delegation of authority.

4. Management Planning, Decision Making and Control:

Steps, hierarchy, principles and dimensions of planning function, Approaches to decision making, Decision support systems, Basic control process, control parameters, principles of control.

5. Plant Location & Layout:

Plant location: definition, factors affecting the plant location, comparison of rural and urban sites-methods for selection. Plant layout**:** Needs for a good layout, Different types viz. Product, process and combination layouts, Introduction to layouts based on the GT, JIT and cellular manufacturing systems, Development of plant layout.

6. Productivity:

Definition, reasons for low productivity, methods to improve productivity, relation between work-study and productivity.

7. Work Analysis:

Definition, need and scope of Work Analysis. Method-study: Definition, objectives, step-by-step procedure, questioning techniques, charts and diagrams for recording data. Principles of motion economy; Development and installation of new method. Work–measurement: Definition, various techniques of work-measurement such as work-sampling, stopwatch time study & its procedure, Job selection, Equipment and Forms used for work measurement, need for rating operator, methods of rating, allowances and their types, standard time. Standard data techniques.

8. Value Engineering:

Definition, Types of values, concept, phases and application of value engineering.

Books:

1. **Philip E** Hick, Industrial Engineering & Management, Tata McGraw Hill
2. Lawrence D. Miles, Techniques of Value Analysis and Engineering, McGraw Hill.
3. R.N. Nauhria, Rajnish Parkash, Management of Systems, Wheeler Publishers
4. S. Buffa, Modern Production Management, Wiley Eastern
5. H.S. Shan, Work Study and Ergonomics, Dhanpat Rai and Co. (P) Ltd.

BTME 802 REFRIGERATION AND AIRCONDITIONING

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

1. 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.

2. Gas Cycle Refrigeration and Aircraft Refrigeration & Air conditioning:
Bell Coleman/Reversed Brayton/ Reversed Joule Cycle and its analysis; Numerical; optimum COP and pressure ratio (No mathematical Analysis); 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; Dry Air Rated Temperature (DART); Comparison of different aircraft refrigeration and air conditioning systems; Numerical.

3. Vapour Compression Refrigeration Cycle:
Vapour compression refrigeration system and its basic components; Representation of Simple/ TheoreticaL vapour compression refrigeration cycle on P-v, T-s and P-h diagrams; 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; 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; Brief introduction (no mathematical analysis) 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); Brief introduction (no mathematical analysis) 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.

4. Vapour Absorption Refrigeration Cycle (No Mathematical Analysis):
Principle of vapour absorption refrigeration; 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.

5. 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; Ecofriendly refrigerants and action plan to reduce ecological hazards.

6. Alternative Refrigeration Systems and Low Temperature Refrigeration:
(No Mathematical Analysis)
Steam Jet Refrigeration; Mixed Refrigeration Systems; Vortex Tube Refrigeration, Thermoelectric cooling; Transcritical Carbon Dioxide Compression Refrigeration; Cascade Refrigeration System; Linde and Claude cycles, cryogenics and its engineering applications.

7. Air Conditioning Concepts and Applications:
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.

8. 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, Air washer; Numerical.

9. 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

10. 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.

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

BTME 803 MECHANICAL VIBRATIONS

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

Detailed contents

1. Introduction:

Basic concepts, Types of vibration, Periodic & Harmonic vibrations, Methods of vibration analysis

2. Vibration of Single Degree of Freedom System:

Undamped free vibrations, damped free vibrations and damped force vibration system, Modelling of stiffness and damping (both viscous and coulomb), estimation of damping by decay plots, vibration isolation transmissibility, vibration measuring instruments.

3. Two degrees of Freedom systems:

a) Principal modes of vibrations, natural frequencies, amplitude ratio, undamped free, damped free, forced harmonic vibration, semi-definite systems, combined rectilinear & angular modes; Lagrange's equation.

b) Application to un-damped and damped absorbers: Vibration absorber – principle; centrifugal pendulum vibration absorber, torsional vibration damper, untuned dry friction and viscous vibration damper, torsional vibration abosrber.

4 Multi-degree of freedom systems:

Undamped free vibrations, influence coefficients, Generalised coordinates, orthogonality principal, matrix iteration method, Rayleigh and Dunkerley, Holzer's , Stodola method, Eigen values and eigen vectors

5. Continuous systems:

Lateral vibrations of a string, longitudinal vibrations of bars, transverse vibrations of beams, Euler's equation of motion for beam vibration, natural frequencies for various end conditions, torsional vibration of circular shafts

Books:

1. G.K. Grover, Mechanical Vibrations Hem Chand and Bros

2. K.K. Purjara, 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

BTME 804 REFRIGERATION AND AIRCONDITIONING LAB

Internal Marks: 30 **External Marks: 20** **Total Marks: 50**

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

Subjects for Departmental Electives

Group-I

DE/ME-1.1 I. C. Engines

Internal Marks: 40 External Marks: 60 Total Marks: 100

1. Introduction to IC Engines:

Definition of engine; Heat Engine, Historical Development of IC Engines, Classification & Nomenclature, Application of IC Engines, Air Standard Cycle, Carnot Cycle, Sterling Cycle, Ericson Cycle, Otto Cycle, Diesel cycle, Dual Cycle, Thermodynamics Analysis of these cycles.

2. Actual Working of I.C. Engine:

Working of 4 stroke petrol & diesel engines and their valve timing diagram, working of 2-stroke petrol & diesel engines & their valve timing diagrams, comparison of two stroke & four stroke engines, Actual working of 2 & 4 stroke gas engine and their valve diagram.

3. Fuel Air Cycles and their analysis:

Introduction to fuel air cycles and their significance, composition of cylinder gases, variable specific heats, Dissociation, effect of no. of moles, comparison of air standards & fuel air cycles, effect of operating variable like compression ratio, fuel air ratio, actual cycles and their analysis; Difference between Actual and Fuel-Air Cycle, Actual and Fuel-Air Cycles for S.I. and C.I. Engines.

4. IC Engine Fuels:

Introduction, types of fuels, solid, liquid and gaseous fuels, chemical structure of petroleum, petroleum refining process, important qualities of S.I. & C.I. Engine fuels and their rating. Combustion of fuels; Calorific valves of fuels, theoretical determination of CV of fuel, combustion equation for hydrocarbon fuels, determination of minimum air required for combustion, conversions of volumetric analysis of mass analysis, Determination of air supplied from volumetric analysis of Dry flue gases, Determination of excess air supplied , Determination of % of carbon in fuel burning to CO & CO2 , Determination of minimum quantity of air supplied to gaseous

5. Fuel Supply System:

Fuel Supply System and fuel pumps, properties of air fuel mixture, a sample carburetor an its working, approximate analysis of simple carburetor, Actual air fuel ratio of single jet carburetor, Exact analysis of single jet carburetor, ideal requirements from a carburetor, limitations of single jet carburetor, different devices used to meet the requirements of an ideal carburetor. Different modern carburetors, introduction to petrol injection, fuel injection systems for C.I.

6. Engines:

classification of injection systems, injection pump, injection pump governor, mechanical governor, fuel injection systems, injection pump Governor, Mechanical Governor, Fuel Injector, Nozzle, Injection of S.I. Engines, Fuel Filters.

7. Combustion in S.I. Engines:

Introduction, Stages of Combination in S.I. Engine, Flame font propagation, factor influencing the flame speed, ignition lag and factors affecting the lag, Abnormal combustion and knocking, control and measurement of knock, rating of S.I. Engine fuels and anti knock agents, combustion chambers of S.I. Engines

8. Supercharging:

Introduction, purpose of supercharging, type of superchargers, analysis of superchargers, performance of superchargers, Arrangement of Supercharger and its installation, Turbo charged engines, supercharging of S.I. & C.I. Engines. Limitations of supercharging.

9. Measurement and Testing:

Measurement of friction horse power, brake horse power, indicated horse power, measurement of speed, air consumption, fuel consumption, heat carried by cooling water, heat carried by the exhaust gases, heat balance sheet, governing of I.C. Engines, performance characteristics of I.C. Engines: Performance parameters, performance of S.I. Engines, performance of C.I. Engine, Engine performance maps

Books:

1. V. Ganesan, Internal Combustion Engines, Prentice Hall.

2. V. M. Damundwar, A Course in Internal Combustion Engines, Dhanpat Rai.

3. John B. Heywood, Internal combustion engine fundamentals McGraw-Hill,

4. Colin R. Ferguson, Allan Thomson, Kirkpatrick Internal combustion engines: applied thermo sciences, John Wiley & Sons

5. Richard Stone, Introduction to Internal Combustion Engines Society of Automotive Engineers,

DE/ME-1.2 CRYOGENIC TECHNOLOGY

Internal Marks: 40 External Marks: 60 Total Marks: 100

PART - I

1. History of cryogenic engineering; application of cryogenics

2. Properties of Oxygen, Nitrogen and Argon, and Hydrogen, Helium and rare gases

3. Thermal, mechanical and electrical properties of engineering materials at low temperature: Introduction to the phenomenon of superconductivity and its applications

PART - II

3. Thermodynamics of ideal liquefaction cycles; Joule-Thomson effect 3 Linde cycle; prncooled linde cycle; exercise

4. Claude, Heylandt, and kapitza cycles; exercises

5. Liquification of hydrogen and helium

PART-III

Heat exchangers and definition of effectiveness

1 Coiled tube (hampson type) and brazed Aluminum heat exchangers

2 Cryogenic expansion engines and turbines

PART -IV

1. Principal of binary Distillation

2. linde signal & double column system

PART -V

3. Types of cryogenic insulation: foam, fibre, powder vacuum

1. Liquid cryogen storage vessels and cryogen transfer line;

PART -VI

2. Measurement of temperature: gas and vapour pressure Thermometers, thermocouple, RTD and semiconductor sensors;

PART -VII

3. Safety in cryogenic systems fir, asphyxiation, cold burns and pressure problems

Books

1. Randall F. Barron, Cryogenic Systems, McGraw-Hill.

2. Marshall Sitting and Stephen Kidd D, Cryogenic Research amd Applications, Van Norstad

3. Russell Burton, Scott Cryogenic engineering, Van Nostrand,

DE/ME-1.3 NON-CONVENTIONAL ENERGY RESOURCES

Internal Marks: 40 External Marks: 60 Total Marks: 100

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.

2. 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.

3. 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 accodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations.

4. 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: thermoionic 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.

5. 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.

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.

DE/ME-1.4 ENERGY CONSERVATION AND MANAGEMENT

Internal Marks: 40 External Marks: 60 Total Marks: 100

Need for energy conservation, its potentials, fiscal incentives, primary energy sources such as coal, gas, oil, nuclear fuel, Optimum use of prime movers for power generation such as steam turbines, gas turbines, diesel and gas engines, energy intensive industries i.e. iron and steel, aluminum, pulp and paper, textile and oil refineries and their energy usage pattern.

Plant Good house keeping measures in air conditioning boilers, combustion system, steam, furnaces and general awareness, Energy audit, methodology and analysis, Energy conservation case studies in air conditioning, boiler and burners

Waste heat recovery systems i.e. recuperates economizers waste heat boilers, heat pipe heat exchangers regenerators etc. energy storage systems thermal storage, insulation, refractory, specialized processes such as Dielectric & micro wave heating, electronic beam welding, Fluidized bed technology, laser as a welding tool, Alternative sources of energy.

Books

1. D.A. Reay, Industrial Energy Conservation Handbook, Oxford Press.

2. P. L. Diwakar Rao, Energy Conservation Handbook, Utility Publication Ltd.

3. Richard Greene, Process Energy conservation (Chemical Engineering), McGraw-Hill.

DE/ME-1.5 FLUID MECHANICS-II

Internal Marks: 40 External Marks: 60 Total Marks: 100

1. 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.

2. 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.

3. Turbulence:

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

4. 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 courved surface boundary layer separation and its control.

5. 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.

6. 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.

Books

1. B.S. Massey, ELBS and Van Nostrand, Mechanics of Fluids, Reinhold Co.

2. Richard H.F. Pao, Fluid Mechanics, John Wiley.

3. D.S. Kumar, Fluid Mechanics and Fluid Power Engineering, SK Kataria.

4. J.F. Douglas, J.M. Gasionckw, and J.A. Swaffield JP, Fluid Mechanics , Pitman.

5. V.L. Streeter and E.B. Wylie, Fluid Mechanics, McGraw Hill.

DE/ME-1.6 SOLAR ENERGY

Internal Marks: 40 External Marks: 60 Total Marks: 100

1. Solar Flux and Weather Data:

Introduction, Solar Constant, Spectrum of sun, Diurnal Variation of Direct Sunlight, Height variation of direct sunlight. Standard Atmosphere, Zenith Distance Flux Variation, Geographical distribution of sun-shine and effects of weather on Solar Flux. Introduction to solar Flux observation, Instruments such as pyranometer, Phyrheliometer and Sunshine Recorder, Correlation between direct and total Insulation, Solar flux variation dynamic, Correlation of sunshine with Wind Velocity, Environmental Thermal Infrared Flux and ETIR Model.

2. Solar Availability:

Introduction, Zenith Distance Vs time, Time of sunrise and sun-set fully Tracking collector, Variation of flux curves with latitude and geometry, Introduction tom Fixed Flat plate (horizontal, latitude Tilted, fixed latitude + 15°, Vertical South-facing, seasonally Tilted) N-S and horz, east west tracking and N-S polar east west tracking, East west horz and N-S tracking, Comparison of theoretical curves with observation, comparison of daily output; Peak flux Vs Average flux.

3. Heat Transfer in Solar Collectors:

Introduction, Heat Losses in a Distributed Collector system. The Liquid Transfer Module System, Solar Heat Availability, Fluid Mechanics, Fluid Properties, Temperature Rise, Solar Flux, Pressure Drop Relations, Reynolds Number, Ratio of Power Expended to Power Generated, Magnitude of Power Output/Input Ratio, Parametric Relationships for Fluid Transfer, Variation of Output/Input Ratio with Solar Flux. Air-Transfer Systems, Air Heat Transfer in Terms of Volume Rate of Flow, Typical Evaluation Situation. Alternative Forms of the Heat-Rise Equation, Effect of Changing Heat-Transfer Fluid, Heat Transfer in Evacuated Collectors, Thermodynamic Utilization of Collected Energy, Evacuated Collectot Trade offs. Linear Absorber with Air Radiation Suppression Using Honeycombs Convection Suppression Using Honey-combs, Heat Pipes, Heat Transfer alongh Thin Sheets, Differential Thermal Expansion, Problems.

4. Flat-Plate Collectors:

Introduction, Basic Collector Configurations, Diurnal Temperature, Profile, Thermal Inertia U-Factor, Collector Heat Balances. Sample Calculation, Surface Temperature. Efficiency versus-Temperature Curves, General Properties of an efficiency Vs Change and Temperature, The Bare Collector; Single –Window Collector, Double Window Collector Improvement of Performance, Geometrical Suppression of Convection, Window Temperature. Effect of Selective Absorber Surface, Selective Windows Facing Selective Surface Combination of Absorber and selective windows, Comparison of Thermal Behaviour for Selective Windows, Window Absorption Non reflection Coated Window, Variation of Efficiency with Solar Flux, Evacuated, Cooling, Selective Radioactive Cooling, Cylindrical Collector Structure Flat-Plate .Collector performance, Solar Ponds, Problems

5. Energy Storage:

Introduction, Basic System Diagram, Peaking Effect of Back up Demands, Energy Storage, Hydrostorage Chemical Batteries Flywheels Chemical Storage, Compressed Air, Biological Storage, Thermal Storage, Sensible-Heat Storage, Latent-Heat Storage, Salt Eutectics, Zoned Thermal Storage Fluid Tank, Rock Thermal Storage Tank, Thermal Storage Tank Farm, Heat Management with and without Phase Change, Thermal inertia, Calculation of Detailed Performance, Problems. Application of Solar Energy (History and Survey Application) Community Heating & Cooling system, Solar Water pumping, Solar gas absorption refrigeration, MEC Cooling system, Two stage evaporative cooling etc.

6. Direct Conversion to Electricity:

Introduction, Direct conversion by Means of Solar Ce4lls, Silicon Cells, Manufacture of Silicon Cells, Efg Ribbon Silicon Cells Polycry Stalline silicon cells, Cadmium sulfide Solar Cells, Manufacture of Cadmium Sulfide Cells Gallium Arsenide Solar Cells, Thermal Behaviors of Solar Cells Cooled Solar Cells for Concentrating System. Thermo-electric Solar Cells, Thermonic Solar Cells, Phase-Change Thermal Direct Conversion, Problems.

Books

1. Aden B.Meinel and Marjoric P.Meinel, An Introduction to Applied Solar Energy, Addison Wesley.

2. Jan F.Kreider and Fran Kreith, Hand Book of Solar Energy, McGraw-Hill.

DE/ME-1.7 Heat Exchanger Design

Internal Marks: 40 External Marks: 60 Total Marks: 100

1. Introduction:

Classification, types and applications of heat Exchangers, Heat Exchanger Design methodology, Selection of Heat Exchangers.

2. Single Phase Heat Exchangers:

LMTD and NTU methods, Rating and sizing methods, design criteria, geometry, process parameters, pressure drops and applications.

3. Two Phase Heat Exchangers:

Types of Boiling, Boiling mechanisms, two phase flow boiling pressure drop Condensation Mechanism, types of condensers and design procedures, Evaporators, Reboilers, Multiple effect evaporators, Design procedures, Liquid chillers, kettle, thermosyphen and forced circulation Reboilers, Augmented surface heat Exchangers, Heat transfer coefficients, pressure drops, compact heat exchangers and air coolers, plate heat exchangers and plate fine heat exchangers.

4. Heat Pipe Heat Exchangers:

Types and design procedure and applications Installation, Operation and Maintenance: Fouling factors, type of fouling and cleaning methods.

5. Mechanical Considerations:

Codes and Standards, Mechanical design requirements and materials.

Books

1. Saunders EAD, Heat Exchangers Selection Design and Construction, Longman Scientific and Technical, John Wiley.

2. D.Q. Kern, Process Heat Transfer International Edition, Mc. Graw Hill.

3. J.P. Holman, Heat Transfer, Mc. Graw Hill.

4. J.P Gupta, Fundamentals of Heat Exchangers and Pressure Vessels Technology, Hemisphere Publishing Corporation.

DE/ME-1.8 POWER PLANT ENGINEERING

Internal Marks: 40 External Marks: 60 Total Marks: 100

1. Introduction:

Energy sources for generation of electric power, Principles types of power plants-their special features and applications, Present status and future trends.

2. Hydro-Electric Power Plants:

Classifications, Components and their general layout, Hydroelectric survey, rainfall run-off, hydrograph, flow duration curve, mass curve, storage capacity, Site selection.

3. Steam Power Plant:

General Introduction, Developing trends, Essential features, Site

Selection, Coal-its storage, preparation, handling, feeding and burning, Ash handling,

dust collection, High pressure boilers.

4. Diesel and Gas Turbine Power Plants:

Field of use, components, Plant layout, Comparison with stream power plants, Operation of combined steam and gas power plants.

5. Nuclear Power Plant:

Nuclear fuels, nuclear energy, Main components of nuclear power plant, Nuclear reactors-types and applications, Radiation shielding, Radioactive waste disposal, Safety aspects.

6. Power Plant Economics:

Load curves, terms and conditions, Effect of load on power plant design, methods to meet variable load, prediction of load, cost of electric energy, Selection of types of generation and generating equipment, Performance and operating characteristics of power plants, Load division among generators and prime movers, Tariff methods of electric energy. Non-Conventional Power Generation: Geothermal power plants, Tidal power plants, Wind power plants, Solar power plants, Electricity from city refuge.

7. Direct Energy Conversion Systems:

Thermoelectric conversion system, Thermionic conversion system, Photo voltaic power system, Fuel Cells, Magneto-hydrodynamic system.

Books

1. P.K.Nag, Plant Engineering, Tata McGraw Hill.

2. G.R. Nagpal, Power Plant Engineering, Khanna Publishers.

3. S.C. Arora and S. Domkundwar, Power Plant Engineering, Dhanpat Rai.

DE/ME-1.9 GAS DYNAMICS

Internal Marks: 40 External Marks: 60 Total Marks: 100

1. Basic concepts of Gas Dynamics and Gas Properties:

Definition: Units and dimensions. The concepts of continuous, properties of the continuum. Methods of describing fluid motion, Lagrangian method. Eulerian Method. The integral form of the equations of Conservations of Mass. Momentum and energy as applied to Control Volumes, applications to the study flow of inviscid compressible fluids.

2. Fundamentals Equations Study of One Dimensional Flow:

Continuity equation, the momentum equation, the dynamic equation and Euller's equation. Bernoulli's equation, thrust function, steady flow energy equation.

3. Isentropic Flow:

Introduction, Acoustic velocity, Mach number, Mach line and Mach angle. Classification of flows, Karman's rules supersonic flow, flow parameters, Critical conditions stagnation values.

4. Flow in Ducts with Heating or Cooling:

Stagnation temp. change, governing equations, Rayleigh lines, choking effects in simple to change. Maximum heat transfer.

5. Flow in constant- Area Ducts with friction:

Friction loss, the friction parameter, Fannolines, effect of the increase of inlet Mach number and duct length. Chocking due to friction. Isothermal flow through long ducts.

6. Normal Shock Waves:

Formation of shock waves, weak waves, compression waves. Governing relations of the Normal shock, Pressure. Temperature, Density, Mach number across shock.

7. Oblique shocks: Oblique shock equations, shock geometry, shock polars.

8. Flow through Nozzles:

The Converging diverging nozzle, area ratio for complete expansion, effect of varying back pressure on nozzle flow. Under-expansion and over-expansion in nozzle flow. Losses in nozzle.

9. Flow through Diffusers:

Classification of diffusers, internal compression subsonic diffuser, velocity gradient, effect of friction and area change, the conical internal-compression subsonic diffuser, external compression subsonic diffuser, supersonic diffuser, normal shock supersonic diffuser, the converging diverging supersonic diffuser.

10. Introduction to Multidimensional Flow:

The equation of continuity, the momentum equations, Bernoulli,s equation, the energy equation, Navier-Stock' Equations, Potential Flow.

Books

1 Asher H. Shaprio, Thermodynamics of Compressible Fluid flow, John Wiley.

2. Culbert B. Laney, Computational Gas Dynamics, Cambridge University Press.

Group-II

DE/PE-2.0 Non Traditional Machining Processes

Internal Marks: 40 External Marks: 60 Total Marks: 100

1. Introduction:

Latest trends in Manufacturing, Introduction to Flexible manufacturing system, Introduction to computer integrated manufacturing, Limitations of conventional machining processes, Development of Non conventional machining processes, their classification, advantages and major applications

2. Advanced Mechanical Processes:

Ultrasonic machining, Water Jet Machining and Abrasive Flow Machining-elements of process, Applications and limitations

3. Electrochemical & Chemical Removal Processes:

Principle of operation, elements and applications of Electrochemical Machining, Electrochemical grinding, Electrochemical deburring, Electrochemical honing, Chemical Machining, Photochemical machining

5. Thermal Metal Removal Processes:

Electric Discharge Machining- Mechanism of metal removal, electrode feed control, die electric fluids flushing, selection of electrode material, applications. Plasma Arc Machining- Mechanism of metal removal, PAM parameters, Equipment's for unit, safety precautions and applications. Laser Beam machining- Material removal, limitations and advantages. Hot machining- method of heat, Applications and limitations. Electon-Beam Machining-, Generation and control of electron beam, process capabilities and limitations

6. Hybrid Machining Processes:

Concept, classification, application, Advantages

Books:

1. P.C. Panday and H.S. Shan, Modern Machining Processes, Tata Mc Graw Hill

2. G. Boothroyd and W.A. Knight, Fundamentals of Machining and Machine Tools, Marcel Dekker Inc.

3. G.F. Benedict, Non-traditional Manufacturing Processes, Marcel Dekker Inc.

4. V.K Jain, Advanced Machining Processes, Allied Publishers

5. Hassan Abdel, Gawad El-hofy Fundamentals of Machining Processes: Conventional and Nonconventional Processes, Taylor & Francis

DE/PE-2.1 INDUSTRIAL ENGINEERING

Internal Marks: 40 External Marks: 60 Total Marks: 100

1. Introduction:

Definition and scope of industrial engineering Role of an industrial engineering Role of an industrial engineer in industry, Functions of industrial engineering department and its organization, Qualities of an industrial engineer.

2. Plant Layout and Material Handling:

Different types of layouts viz. Product, process and combination layouts, Introduction to layouts based on the GT, JIT and cellular manufacturing systems, Development of plant layout. Types of material handling equipment, relationship of material handling with plant layouts.

3. Work-study:

Areas of application of work study in industry; Method study and work measurements and their inter-relationship. Reaction of management and labour to work study; Role of work study in improving plant productivity and safety.

4. Method Study:

Objectives and procedure for methods analysis: Select, Record, Examine, Develop, Define, Install and Maintain. Recording techniques, Micromotion and macro-motion study: Principles of motion economy, Normal work areas and work place design.

5. Work Measurement:

Objectives, Work measurement techniques - time study, work sampling, pre-determined motion time standards (PMTS) Determination of time standards. Observed time, basic time, normal time, rating factors, allowances, standard time.

6. Value Engineering:

Types of values, concept of value engineering, phases of value engineering studies, application of value engineering.

7. Work Design:

Concepts of job enlargement, job enrichment and job rotation. Effective job design considering technological and behavior factors.

8. Ergonomics:

Introduction to ergonomic considerations in designing man-machine systems with special reference to design of displays and controls.

Books

1. Gayler Shotbolt, Introduction to Work study, Tata McGraw Hill.

2. H.S. Shan, Work Study and Ergonomics, Dhanpat Rai and Co. (p) Ltd.

3. R. Bernes, Motion and time study by, John-Wiley.

4. D.J. Oborne, Ergonomics at work, John Wiley.

5. D. Miles, Techniques of Value Analysis and Engineering, McGraw Hill.

DE/PE-2.2 MODELING AND SIMULATION

Internal Marks: 40 External Marks: 60 Total Marks: 100

1. Modeling

Need for system modeling, systems approach to modeling, open and feed back systems, combination of simple feed back systems, feed back time lag effects, feed back and managerial systems

2. Production and Operations Management

Principle of analytical modeling, kinds of analytical methods, measures of effectiveness, cost analysis large systems

3. Simulation

Monte Carlo simulation, generation of stochastic variates, continuous and discrete probability distributions, application of Monte Carlo methods for production systems, computer simulation

models, Macro Dynamic models, examples from business and industry, design of management game, Simulation languages SIMULA, SIMSCRIPT, GPSS etc. Statistical output analysis.

4. Analog computer simulation;

Basic analog computer components and operations; amplitude and time scaling; solution of linear and non-linear partial differential equations, formulation of model for a dynamic system and its simulation on analog computer.

Books

1. Narsingh Deo, System Simulation with Digital Computer, PHI Learning.

2 G. Gordon, System Simulation, PHI Learning.

3. Jackson A.S, Analog Computation, McGraw-Hill.

4. Naylor T.H. et. al, Computer Simulation Techniques, John Wiley.

5. S. Buffa, Modern Production Management, John Wiley .

DE/ME-2.3 OPERATIONS MANAGEMENT

Internal Marks: 40 External Marks: 60 Total Marks: 100

1. Need and Scope of Operation Management:

Types of production system and their characteristics, productivity definition, types and measurements

2. 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. Discussion of case studies. Feasibility and locational analysis.

3. 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

4. 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

5. 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.

6. 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.

7. 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.

8. Management Information Systems:

Introduction to MIS, Steps in designing MIS, Role of Computers in MIS.

9. Maintenance Systems:

Type of maintenance, objective of maintenance, Planned maintenance strategies, preventive maintenance, condition monitoring and total productive maintenance

BOOKS:

1. S.N. 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.

4. Elwood S. Buffa, Modern Production Management, John Wiley.

5. E. L. Grant and R.S. Leaven Worth, Statistical Quality Control, McGraw Hill.

DE/ME-2.4 NON-DESTRUCTIVE TESTING

Internal Marks: 40 External Marks: 60 Total Marks: 100

1. Introduction:

Classification of techniques of material testing, Need and Significance of Non Destructive Testing methods, type of Non Destructive testing methods.

2. 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.

3. Magnaflux methods:

Basic principles, scope and applications, magnetic analysis of steel bars and tubing magnetization methods, equipment, inspection medium, preparation of surfaces Fluorescent Penetration inspection, Demagnetization.

4. Electrical and ultrasonic Methods:

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

5. Photoelasticity:

Concept and applications of Plane and circular polarization, Photo stress, models.

Books

1. H.E. Davies, G.E Troxell and GFW Hauck, The testing of Engg materials, Mc Graw Hill.

2. W.H Armstrong, Mechanical Inspection, Mc Graw Hill.

DE/ME-2.5 TOTAL QUALITY MANAGEMENT

Internal Marks: 40 External Marks: 60 Total Marks: 100

1. Quality and Total Quality Management:

Excellence in manufacturing/service, factors of excellence, relevance of TQM.

2. Concept and definition of quality:

Total quality control (TQC) and Total Quality Management (TQM), salient features of TQC and TQM. Total Quality Management Models, benefits of TQM.

3. Just-in-time (JIT):

Definition: Elements, benefits, equipment layout for JIT system, Kanban system MRP (Material Requirement planning) vs JIT system, Waste elimination, workers involvement through JIT: JIT cause and effect chain, JIT implementation.

4. Customer:

Satisfaction, data collection and complaint, redressal mechanism.

5. Planning Process:

Policy development and implementation; plan formulation and implementation.

5.Process Management:

Factors affecting process management, Quality function development (QFD), and quality assurance system.

7. Total Employees Involvement (TEI):

Empowering employees: team building; quality circles; reward and Recognition; education and training, Suggestion schemes.

8. Problems solving:

Defining problem, Problem identification and solving process, QC tools.

9. Benchmarking:

Definition, concept, process and types of benchmarking.

10. Quality Systems:

Concept of quality system standards: relevance and origin of ISO 9000; Benefits; Elements of ISO 9001, ISO 9002, ISO 9003.

11. Advanced techniques of TQM:

Design of experiments: failure mode effect analysis: Taguchi methods.

BOOKS:

1. Sunder Raju, Total Quality Management , Tata McGraw Hill.

2. M.Zairi, TQM for engineers, Aditya Books.

3. J.L. Hradeskym, Total Quality Management Handbook, McGraw Hill.

4. Dalela and Saurabh, ISO 9000 quality System, Standard Publishers.

DE/ME-2.6 MAINTENANCE AND RELIABILITY ENGINEERING

Internal Marks: 40 External Marks: 60 Total Marks: 100

1. Introduction:

Objective and characteristics of maintenance function, Organization of the maintenance system, Operating practices in maintenance, Maintenance record keeping.

2. Cost Aspect of Maintenance:

Costs of machine breakdown, estimation of life cycle costs, Application of work measurement in maintenance, Manpower planning and training, Incentive payments for maintenance.

3. Planning of Maintenance Activities:

Evaluation of alternative maintenance policies breakdown, preventive and predictive maintenance, fault diagnosis and condition monitoring techniques, simulation of alternative

practices, Development of preventive maintenance schedule, House keeping practices, total productive maintenance.

4. Maintenance Engineering:

Maintenance requirements of mechanical, electrical, process and service equipment, Safety aspect in maintenance, Aspect of lubrication; chemical control of corrosion, Computerized maintenance information systems.

5. Reliability:

Concept and definition, configuration of failure data, various terms used in failure data analysis in mathematical forms, component and system failures, uses of reliability concepts in design and maintenance of different system.

6. Reliability and Availability of Engineering systems:

Quantitative estimation of reliability of parts, Reliability of parallel and series elements, Accuracy and confidence of reliability estimation, Statistical estimation of reliability indices, Machine failure pattern, Breakdown time distribution.

7. Reliability improvement:

Reliability in design, reliability in engineering, systems, systems with spares, reliability simulation, redundant and stand by systems, confidence levels, component improvement element, unit and standby redundancy optimization and reliability-cost trade off.

8. Fault Tree Analysis:

Introduction and importance, fault tree construction, reliability calculations from fault tree, tie set and cut set methods, event tree and numerical problems.

Books

1. Lindley R. Higgins, Maintenance Engineering Handbook, McGraw Hill.

2. R.H. Clifton, Principles of Planned Maintenance, Edward Arnold.

3. A Kelly, Maintenance Planning control, McGraw Hill.

4. L.S Srinath, Reliability Engineering, East West Press.

5. S.K. Sinha, Reliability Engineering, John Wiley.

DE/ME-2.7 MATERIAL MANAGEMENT

Internal Marks: 40 External Marks: 60 Total Marks: 100

1. Introduction:

Meaning, definition, functions of materials management, Concept of integrated material management, Relationship of material management with other Organizational functions.

2. Material Planning & Budgeting:

Need for material planning, Factors affecting material planning, Techniques of material planning, Material classification, codification and standardization, Material budgeting - meaning and need, techniques of material budgeting.

3. Inventory Control:

Need and meaning of inventory, types of inventory, functions of inventory control, Inventory costs, Inventory control tool - ABC, VED, XYZ and FSN: Economic order Quantity and replenishment of stocks. Physical control of inventory: Fixed order, Two bin and Kardex systems - Material requirement planning (MRP-I) Spare parts control for maintenance purposes. Evaluation of inventory control performance. Concept of Just-in-Time(JIT). Use of computers for inventory control

4. Purchasing:

Purchasing principles, procedures and systems, Functions of purchasing, Make-or-buy decision, Vendor development and vendor rating. Factors affecting purchase decisions, Legal aspects of purchasing, Documentation and procedure for import.

5.Storage:

Functions and importance of store keeping, types of stores, store accounting and store verification, Legal aspects of store keeping, Management of surplus, scrap and obsolete items. Importance of material handling in store keeping, handling equipment.

Books

1. M.M. Verma, Materials Management, S. Chand and Co.

2. Gopal Krishnan and Sundaresan, Material Management - An Integrated Approach, Prentice Hall

3. Dobbler and Burt, Purchasing and materials management, Tata McGraw Hill

4. M. Starr and D. Miller, Inventory control, Prentice Hall.

DE/ME-2.8 MANAGEMENT INFORMATION SYSTEM

Internal Marks: 40 External Marks: 60 Total Marks: 100

1. Information and Decision Making:

Concept of information; data versus information, characteristics of information, classification of information, cost and value of information, Use of information in the decision making process, information requirements for decision making, types of decisions, decision making process, decision making models role of information system, decision support systems, expert systems.

2. Management Information Systems (MIS):

Concept, Characteristics and importance of management information systems, types of information systems role of computers in management information systems, hierarchy of data processing systems, operating elements of MIS, information needs of MIS, storage and retrieval of data processing, functions of information systems, management reports. Analysis and design cycle for MIS. Various approaches to system analysis and design. Strategic and project Planning for MIS, analysis and design, matching mission, objectives and plans of MIS with business plans, project planning for MIS, Conceptual system design, Detailed system design, Implementation, Evaluation and Maintenance of MIS.

3. Computer Networks and Data Communication Computer network:

Local Area networks; characteristics topologies network structures, switching networks, OSI standards for multi vendor network. I.A.N standards, application of networks, Data Communication concepts, types and modes of transmission, hardware requirements, communication controllers, Data Communication software, data communication protocol.

4. Data Base Management Systems:

Introduction, data base designing, relational data base management system. Introduction to computerized data base management system.

Books

1. Robert G. Mudrick, Joel E. Ross and James R. Clagget, Information System for Modern Management, Prentice Hall.

2. G. Davis and M. Olson, Management Information systems, McGraw Hill

3. Henry C. Lucas, Information systems for management, McGraw Hill.

DE/ME-2.9 ENTREPRENEURSHIP

Internal Marks: 40 External Marks: 60 Total Marks: 100

1.Concept of Entrepreneurship:

Entrepreneurship and small scale industry, need for promotion of entrepreneurship, entrepreneurship development programmes (EDP), personality characteristics of entrepreneur.

2. Identification of Investment Opportunities:

Governmental regulatory framework, industrial policy, industrial development and regulation act, regulation of foreign collaboration and investment, foreign exchange regulation act, incentives for export oriented units, incentives for units in industrially backward areas, incentives for small scale industry, government assistance to SSI, how to start and SSI, list of items reserved for SSI, Scouting for project ideas, preliminary screening, project identification for an existing company.

3. Market and Demand Analysis:

Information required for market and demand analysis, market survey, demand forecasting, uncertainties demand forecasting.

4. Cost of Project and Means of Financing:

Cost of project, means of financing, planning the capital structure of a new company, term loan financial institutions, cost of production.

5. Financial Management:

Concept and definition of financial management types of capital, of finance, reserve and surplus, concepts and liabilities, profit and loss statement balance sheet, depreciation, methods of calculating depreciation break even analysis.

Books:

1. E.D.I. Ahmedabad, Publication regarding Entrepreneurship.

2. Prasanna Chandra, Project Preparation, Appraisal Budgeting and Implementation, McGraw Hill. .

4. C.S.Gupta and N.P.Srinivasan, Entrepreneurial Development, S. Chand and co.

5. S. S. Khanka, Entrepreneurship Development Practice and Planning, S. Chand and co.

Group-III

DE/PE-3.0 PRODUCT DESIGN AND DEVLOPMENT

Internal Marks: 40 External Marks: 60 Total Marks: 100

1. Visual Design:

Basic elements and concept of visual design-line color, Balance proportion, Size shape mass, unity and variety, Special relationships and composition in two and three dimensions.

2. Form and Color:

Elementary forms their characteristics and significance in design. Form transition, Form in relation to ergonomics, material and manufacturing process, color as an element of design, color clarification dynamics, interrelation of colors, colors and traditions; Psychological use of color form and material.

3. Product Graphics:

Meaning and objectives of product graphics. Basic principles of graphic design, Visual communication aspects of product graphics, Graphics of displays and control panels,

4. Product Detailing:

Standard fastening and joining details in different materials; Temporary and permanent joints: Detailing for plastic products, Detailing for fabricated products in sheet metal.

5. Products Development:

Definition and objective, Role of designer in product development. Manufacturing and economic aspects of product development, Product promotions, product developments.

BOOKS:

1. W.H. Mayal, Industrial Design for Engineers, London Liifee Books Ltd.

2. Huchingson R. Dale, New Horizons for Human Factors in Design, McGraw Hill.

3. N.L. Svensson, Engineering Design.

4. R. Matousek, Engineering Design.

5. K. J. Mccormick (Ed), Human Factor Engineering, McGraw Hill.

DE/PE-3.1 MACHINE TOOL DESIGN

Internal Marks: 40 External Marks: 60 Total Marks: 100

1. 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.

2. Kinematics of Machine Tools:

Kinematics or gearing diagram of Lathe, drilling Machine, Milling Machine etc. Main. drive and feed drive, principles specification of Machine tool.

3. Design of Kinematics Scheme:

Methods to determine transmission ratios for drives,. Development of Kinematics scheme, minimum of transmission groups, Determination of number of teeth on gears.

4. Speed and Feed Boxes:

General requirement Design of gear trains, speed boxes types, speed changing devices, Feed boxes characteristics of feed mechanism, types of Rapid traverse mechanisms, variable devices.

5. Spindle Design and Spindle Bearings:

Main requirement, Materials and details of spindle design, Spindle bearings, bearings, types of bearings and their selections, Bearing Materials BED,

6. Columns, Tables and Ways:

Materials, typical constructions and design.

7. Machine Tools Control Systems:

Requirement of control system selection and construction of control systems Mechanical control system, predilection control, remote control safety devices.

8. Machine Tool Dynamics:

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

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.

5. S.K. Basu and D.K. Pal, Design of machine tools, Oxford and IBH.

DE/PE-3.1 OPTIMIZATION TECHNIQUES

Internal Marks: 40 External Marks: 60 Total Marks: 100

1. Introduction : Origin of OR and its role in solving industrial problems : Generalapproach for solving OR problems. Classification of mathematical models: variousdecision making environments.

2. Linear Programming: Formulation of linear mathematical models: Graphical and simplex techniques for solution of linear programming problems, Big M method and two phase method, Introduction to duality theory and sensitivity analysis.

3. 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.

4. Dynamic Programming: Introduction to deterministic and probabilistic dynamic programming.

5. Queuing Theory: Types of queuing situation: Queuing models with Poisson's inputand exponential service, their application to simple situations.

6. Replacement Models: Replacement of items that deteriorate, Replacement ofitems whose maintenance and repair costs increase with time, replacement of itemsthat fail suddenly;

replacement of items whose maintenance costs increase with timeand value of money also changes, individual replacement policy, group replacement policy.

7. Network models: Shortest route and traveling sales - man problems, PERT &CPM introduction, analysis of time bound project situations, construction of net works,identification of critical path, slack and float, crashing of network for cost reduction.

8. Non-linear Programming Models: Introduction to non-linear programming models. Problems related to the topic.

BOOKS:

1. H.M Wagner, Principles of Operations Research, Prentice Hall.

2. P.K. Gupta and D.S. Hira, Operations Research, S. Chand & Co.

3. F.S. Hiller and G.I. Libermann, Introduction to Operation Research, Holden Ray.

4. A Management Guide to PERT/CPM Wiest & Levy Prentice Hall

DE/ME-3.3 TOOL DESIGN

Internal Marks: 40 External Marks: 60 Total Marks: 100

1. Process Planning:

Product Engineering, Process Engineering, Definition of Process Planning, Contents of Process Plan, Process Operations, Steps of Process Planning, Process Planning Sheet, Planning and Tooling for Low Cost Planning.

2. Jigs and Fixture:

Principles of jig and fixture design, Principle of degrees of freedoms, methods of locations and clamping, Various devices for location and clamping, indexing devices, Hydraulic and pneumatic actuation of clamping devices, jig bushes, use of standard parts of jig design, type of drilling jigs, milling fixtures, lathe fixture, grinding fixtures and their classification.

3. Die Design:

Components of die design, design of die blocks, punches and strippers, methods of holding punches, sketches of stock stops, Design procedure for progressive dies, compound dies and combination dies for press tool operation forging die design for drop and machine forging parts.

4. Tool Layout for Turrets:

Characteristics of Turret lathes, Differences between capstan and turret lathes, methods of holding jobs on the Turret lathe, Universal chucking equipment, universal bar equipment, operation sheet and tool layout.

5. Tool Layout for Automatics:

Classification of Automatics, Turret type automatic, tool layout procedure, time required for each operation, operation sheet, tool layout, cam layout.

6. Tooling Costs:

Estimating cost of a product, estimating costs of tools, Economics of tooling, Break even point analysis, minimum cost analysis.

7. Gauges:

Limits and fits, Plain Gauges, types of Gauges, fundamentals of Gauge Design, Gauge makers tolerance, allowance for wear, Practical application of Taylor's principles of limit gauging, care of Gauges, Limitation of Limit Gauging.

8. Surface Finish:

Elements of surface finish, Factors affecting surface finish, Effect of surface quality on Functional properties of machine parts, Evaluation of surface finish, Indian Standards on surface finish. Measurement of surface finish, Relationship of surface finish to the production methods. Finishing operations like honing, lapping, buffing super finishing etc.

Books:

1. Cole: Tool Design.

2. C. Donaldson, Tool Design, Mc Graw Hill

3. ASTM, Fundamentals of Tool Design.

4. P.C.Sharma, A Textbook of Production Engineering, S.Chand Publication.

DE/ME-3.4 FINITE ELEMENT METHOD

Internal Marks: 40 External Marks: 60 Total Marks: 100

1. Introduction:

General description of the method summary of the analysis procedure

2. Discretisation of the domain:

Type of elements, location of nodes, number of elements, simplification on offered by physical configuration of body, node numbering scheme.

3. One and Two Dimensional Problems:

Introduction, coordinates and shape functions, Potential energy approach, Galerkin Approach, Assembly of the global stiffness matrix and load vector , FEM equations and treatment of boundary conditions, quadratic shape functions, Two dimensional problems using constant strain triangles

4. Axisymmetric solids subjected to axisymmetric loadings:

Axisymmetric formulation, FEM using triangular element, problem using boundary conditions.

5. Static analysis:

Plain and three Dimensional Trusses, Assembly of global matrix for the banded and skyline solutions, Beams and frames in various different conditions.

6. Dynamic Analysis:

Dynamic equation of motion, consistent mass matrix for truss element frame element and triangular plate element, evaluation of eigen values and eigen vectors.

7. Solution of finite element equations:

Direct integration methods, central difference method, Houbolt method, Wilson method, Newmark method, mode superposition method,

Books:

1. Bathe, Finite Element Procedures in Engineering Analysis, Prentice Hall.

2. Chandrupatla and Belegundu, Introduction to Finite Element in Engineering, Prentice Hall.

3. Cook, Concepts and Applications of Finite Element Analysis, John wiley.

DE/ME-3.5 EXPERIMENTAL STRESS ANALYSIS

Internal Marks: 40 External Marks: 60 Total Marks: 100

1. Basic Elasticity:

Laws of stress transformation, principal stresses and principal planes, Cauchy's stress quadric strain analysis, strain equations of transformation, Cauchy's strain quadric, stress, strain relationship.

2. Two Dimensional Photoelasticity:

Stress optics law, Optics of polarisation plane and circular polariscope, dark and light field arrangements, fringe multiplication, fringe sharp ending, compensation techniques, commonly employed photo elastic materials.

3. Dimensional Photoelasticity:

Neuman's strain optic relationship, stress freezing in model materials for three dimensional photoelasticity, shear difference method for stress separation.

4. Birefringence Coatings:

Sensitivity, reinforcing effects, thickness of birefringence coatings.

5. Electric Resistance Strain Gauges:

Gauge construction and installation, temperature compensation, gauge sensitivities, gauge factor, corrections for transverse strain effects, factors affective gauge relation, rosetters Rosetre analysis, potentiometer and whetstone's bridge circuits for strain measurements.

6. Brittle Coatings:

Introduction, coating stresses and failure theories, different types of crack patterns, crack detection composition of brittle coatings, coating cure, influence of atmospheric conditions, effects of biaxial stress field.

Books:

1. Dally and Rilley, Experimental Stress Analysis, McGraw Hill.

2. Dow and Adams, Experimental Stress Analysis and Motion Measurement, Prentice Hall.

3. Durelly and Riley, Introduction to Photo Mechanics, Prentice Hall.

DE/ME-3.6 INDUSTRIAL TRIBOLOGY

Internal Marks: 40 External Marks: 60 Total Marks: 100

1. Introduction:

Tribological considerations, Nature of surfaces and their contact, Physic mechanical properties of surface layer Geometrical properties of surfaces, methods of studying surfaces, Study of contract of smoothly and rough surfaces.

2. Friction and Wear:

Role of friction and laws of static friction, causes of friction , adhesion theory, Laws of rolling friction, Friction of metals and non-metals; Friction measurements. Definition of wear, mechanism of wear, friction affecting wear, wear measurement, Wear of metals and non-metals.

3. 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, properties of liquid and grease lubricants; lubricant additives , general properties and selection.

4. Special Topics:

Selection of bearing and lubricant, bearing maintenance, diagnostic maintenance of tribological components, lubrication systems, Filters and filtration.

Books:

1. O'Conner and Royle, Standard Hand Book of Lubrication Engg., McGraw Hill.

2. Halling and Wykeham, Introduction to Tribology, Publications Ltd.

3. Raymono O.Gunther, Lubrication, Bailey Bros and Swinfan Ltd.

4. PT Barwll, Rearing Systems, Principles and Practice,Oxford press.

5. A Cameron, Basic Lubrication Theory, Wiley (Indian Edition).

DE/ME-3.7 THEORY OF PLASTICITY

Internal Marks: 40 External Marks: 60 Total Marks: 100

1. Introduction to Plasticity:

Idealized stress-strain systems, approximate equation for stress strain curves (Ramberg-Osgood, Ludwig's and Karunes equations), Bauschinger effect-yield locus, yield surface.

2. Yield Criteria and Flow Rules:

Tresca theory & Von-Mises yield criterion, their geometrical representation, experimental evidence for the criteria.

3. Slip Line Field Theory:

Two-dimensional plasticity, slip lines, basic equations, Hencjy's first theorem, Geiringer's Velocity equation, Applications of slip line field theory to plane strain problems.

4. Load Bounding:

The lower bound theorem, the upper bound theorem and their corollaries. Application of load bounding to plane strain problems.

Books

1. Johanson and Miller, Plasticity for mechanical Engineers, Van Nostrand.

2. Calladina, Engg Plasticity, Pergmean Press.

DE/ME-3.8 MECHATRONICS

Internal Marks: 40 External Marks: 60 Total Marks: 100

1. Introduction to Mechatronics:

Definition and approach of Mechatronics, Measurement and Control Systems, Microprocessor based controllers and Mechatronics Approach.

2. Sensors and Transducers:

Performance Terminology, Displacement, velocity, Position, Proximity, force, fluid pressure, liquid level, temperature, light sensors, procedure for selection.

3. Signal Conditioning:

Op Amp, Protection, digital signals, Multiplexes and digital signal processing, pulse modulation

4. Pneumatic and Hydraulic Systems:

Actuation systems, Directions, pressure and process control valve, Pneumatic and hydraulic systems

5. Electrical Actuation System:

Mechanical Switches, Solid State Switches, Solenoid, DC/AC Motors, Stepper Motors

6. Microprocessor and Its Application:

Architecture of Microprocssor 8085, Instruction set, Embedding a microprocessor into a Mechatronics system.

7. Microprocessor Based Project:

Assemble a suitable system using microprocessor kit for its control.

Books:

1. W. Bolton, Mechatronics, Pearson Education.

2. Rafiquzzaman, Microprocessors.

3. S. Boennett, Real time computer controls, Prentice Hall.

4. Benjamin C. Kuo, Automatic Control Systems, Prentice Hall.