For Batches 2015 & Onwards
Academic Autonomous Institute (No. F22-1/2014 (AC)

BEANT COLLEGE OF ENGINEERING AND TECHNOLOGY GURDASPUR-143521 (PUNJAB)

SCHEME & SYLLABUS

(Modified as per Minutes of 3rd meeting of Academic Council)

B.Tech. Mechanical Engineering

Batch-2015 Onwards

By
Department of Academics
BEANT COLLEGE OF ENGINEERING & TECHNOLOGY
GURDASPUR

3rd Semester-B.Tech. Mechanical Engineering								
Code	**Title of the course**	**L**	**T**	**P**	**Maximum Marks**		**Total Marks**	**Credits**
					Internal	**External**		
BTME-301	Strength of Materials-I	3	1	-	40	60	100	4
BTME-302	Theory of Machines-I	3	1	-	40	60	100	4
BTME-303	Machine Drawing	1	-	4	40	60	100	3
BTME-304	Applied Thermodynamics-I	3	1	-	40	60	100	4
BTME-305	Manufacturing Processes-I	4	-	-	40	60	100	4
BTME-306	Engineering Materials and Metallurgy	3	-	-	40	60	100	3
BTME-307	Engineering Materials and Metallurgy Lab	-	-	2	30	20	50	1
BTME-308	Strength of Materials Lab	-	-	2	30	20	50	1
BTME-309	Applied Thermodynamics Lab	-	-	2	30	20	50	1
BTME-310	Workshop Training*	-	-	-	60	40	100	1
	Advisory meeting**	-	-	-	-	-	-	-
	Total	**17**	**3**	**10**	**390**	**460**	**850**	**26**

Total Contact Hours Per Week = 30

***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.**

****Advisory meeting for one hour per week.**

4th Semester-B.Tech. Mechanical Engineering								
Code	**Title of the course**	**L**	**T**	**P**	**Maximum Marks**		**Total Marks**	**Credits**
					Internal	**External**		
BTME-401	Strength of Materials-II	4	1	-	40	60	100	5
BTME-402	Theory of Machines-II	4	1	-	40	60	100	5
BTME-403	Fluid Mechanics	4	1	-	40	60	100	5
BTME-404	Applied Thermodynamics-II	4	1	-	40	60	100	5
BTME-405	Manufacturing Processes-II	3	-	-	40	60	100	3
BTME-406	Fluid Mechanics Lab	-	-	2	30	20	50	1
BTME-407	Manufacturing Processes Lab	-	-	2	30	20	50	1
BTME-408	Theory of Machines Lab	-	-	2	30	20	50	1
BTGF-400	General Fitness	-	-	-	100	-	100	1
	Advisory meeting*	-	-	-	-	-	-	
	Total	**19**	**4**	**6**	**390**	**360**	**750**	**27**

Total Contact Hours Per Week = 29

***Advisory meeting for one hour per week**

NOTE:-There shall be industrial/institutional training of six (06) weeks duration (Minimum 36 hours per week) at the end of 4th semester. The marks for the same will be included in the 5th semester.

5th Semester-B.Tech. Mechanical Engineering								
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	3	-	-	40	60	100	3
BTME-503	Mechanical Measurement and Metrology	3	-	-	40	60	100	3
BTME-504	Fluid Machinery	3	1	-	40	60	100	4
BTME-	Open Elective-I	3	-	-	40	60	100	3
BTME-505	Computer aided Design and Manufacturing Lab	-	-	2	30	20	50	1
BTME-506	Mechanical Measurement and Metrology Lab	-	-	2	30	20	50	1
BTME-507	Fluid Machinery Lab	-	-	2	30	20	50	1
BTME-508	Industrial Training*	-	-	-	60	40	100	1
	Advisory meeting**	-	-	-	-	-	-	
	Total	**19**	**4**	**6**	**390**	**460**	**850**	**27**

Total Contact Hours Per Week = 29

*** The marks of Industrial/Institutional Training imparted at the end of 4th Semester will be included here.**
**** Advisory meeting for one hour per week.**

6th Semester-B.Tech. Mechanical Engineering								
Code	**Title of the course**	**L**	**T**	**P**	**Maximum Marks**		**Total Marks**	**Credits**
					Internal	**External**		
BTME-601	Design of Machine Elements-II	4	2	-	40	60	100	6
BTME-602	Industrial Automation and Robotics	4	-	-	40	60	100	4
BTME-603	Statistical and Numerical Methods in Engineering	3	1	-	40	60	100	4
BTME-604	Automobile Engineering	3	-	-	40	60	100	3
BTME-	Departmental Elective-I	3	-	-	40	60	100	3
BTME-	Open Elective-II	3	-	-	40	60	100	3
BTME-605	Industrial Automation and Robotics Lab	-	-	2	30	20	50	1
BTME-606	Automobile Engineering Lab	-	-	2	30	20	50	1
BTME-607	Minor Project*	-	-	2	30	20	50	1
BTGF-600	General Fitness	-	-	-	100	-	100	1
	Advisory meeting**	-	-	-	-	-	-	-
	Total	**20**	**3**	**6**	**430**	**420**	**850**	**27**

Total Contact Hours Per Week = 29
***The project work will be carried out in parts as minor project in 6th semester and major project in 7th 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 as major project in 7th semester. The minor project may be carried out by a group of students (2 to 4).**
****Advisory meeting for one hour per week.**

7th Semester-B.Tech. Mechanical Engineering								
Code	**Title of the course**	**L**	**T**	**P**	**Maximum Marks**		**Total Marks**	**Credits**
					Internal	**External**		
BTME-801	Industrial Engineering	3	1	-	40	60	100	4
BTME-802	Heat Transfer	3	1	-	40	60	100	4
BTME-803	Refrigeration & Air Conditioning	3	1	-	40	60	100	4
BTME-804	Mechanical Vibrations	3	1	-	40	60	100	4
BTME-	Department Elective-II	3	-	-	40	60	100	3
BTME-805	Heat Transfer Lab	-	-	2	30	20	50	1
BTME-806	Refrigeration & Air Conditioning Lab	-	-	2	30	20	50	1
BTME-807	Mechanical Vibration lab	-	-	2	30	20	50	1
BTME-808	Major Project*	-	-	6	100	50	150	3
BTGF-800	General Fitness	-	-	-	100	-	100	1
	Advisory meeting**	-	-	-	-	-	-	-
	Total	**15**	**4**	**12**	**490**	**410**	**900**	**26**

Total Contact Hours Per Week = 31

***The problem formulated in the minor project during 6th Semester is to be extended and executed as 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.**

****Advisory meeting for one hour per week.**

8th Semester-B.Tech. Mechanical Engineering					
Code	**Title of the course**	**Maximum Marks**		**Total Marks**	**Credits**
		Internal	**External**		
BTME-701	Industrial Training	450	300	750	24

Total Contact Hours per Week = 36 (minimum)

Note: Students have to undergo Industrial Training in reputed industries for complete one semester.

Department Electives:

Departmental Elective-I

BTME-911 I.C. Engines
BTME-912 Non-Conventional Energy Resources
BTME-913 Operations Research
BTME-914 Product Design and Development
BTME-915 Finite Element Method
BTME-916 Cryogenic Technology
BTME-917 Total Quality Management

Departmental Elective-II

BTME-931 Non-Traditional Machining
BTME-932 Power Plant Engineering
BTME-933 Non-Destructive Testing
BTME-934 Industrial Tribology
BTME-935 Mechatronics
BTME-936 Modeling and Simulation
BTME-937 Maintenance and Reliability Engineering
BTME-938 Machine Tool Design

Open Electives:

Open Elective-I
BTME-951 Industrial Safety and Environment
BTME-952 Energy Conservation and Management

Open Elective-II

BTME-961 Entrepreneurship
BTME-962 Management Information System
BTME-963 Materials Management

Note: Open Elective subjects offered by Department of Mechanical Engineering are only for the students of other departments of the college. Students of B. Tech. Mechanical Engineering will study the Open Elective subjects offered by other departments of the college. Minimum ten (10) students are required to offer Department Elective and Open Elective subjects.

Third Semester

BTME-301 Strength of Materials-I

Internal Marks:	**40**	**L T P**
External Marks:	**60**	**3 1 0**
Total Marks:	**100**	

Course Objective: 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.

1. 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. (10)

2. 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 (8)

3. 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. (5)

4. 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. (5)

5. 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. (4)

6. 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. (8)

Suggested Books:

1. D.S. Bedi, Strength of Materials, Khanna Book Publishing Company.
2. E.P. Popov, Mechanics of Materials-(SI Version), Prentice Hall India.
3. R.S Lehri and A.S. Lehri, Strength of Materials, Kataria and Sons.
4. S.S.Rattan, Strength of Materials, Tata McGraw Hill.
5. Timoshenko and Young, Elements of Strength of Materials, East West Press (EWP).
6. James M Gere and Barry J. Goodno, Strength of Materials, Cengage Learning.
7. James M Gere, Mechanics of Materials, Thomson Brooks/Cole/Pearson, 2006.
8. R.C. Hibbeler, Mechanics of Materials, 6th Edition, Pearson Education, 2007.

BTME-302: Theory of Machines-I

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

L T P
3 1 0

Course Objective: 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. (4)

1. 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 Coriolis components). (8)

2. 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 (4)

3. 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. (8)

4. 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. (6)

5. 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 (6)

6. 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. (4)

7. 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. (4)

Suggested Books:

1. S. S. Rattan, Theory of Machines, Tata McGraw Hill.
2. Jagdish Lal, Theory of Mechanisms & Machines, Metropolitan Book Co.
3. Thomas Beven, Theory of Machines, Longman's Green & Co.
4. W. G. Green, Theory of Machines, Blackie & Sons.
5. V.P. Singh, Theory of Machines Dhanpat Rai.

BTME-303: Machine Drawing

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

L T P
1 0 4

Course Objective: 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.

Note:
1. Drawing Practice is to be done as per code IS: 296.
2.First angle projection to be used. Drawings should contain bill of materials and should illustrate surface finish.
3.The syllabus given below 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.
4.The end term paper shall be having following structure / weight age:
5.Short/objective type questions based upon whole syllabus - 30%
6.Free Hand sketching of machine parts etc. - 20%
7.Assembly drawing of machine parts with at least two views - 50%

1. 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. (2)

2. Fasteners

Various types of screw threads, types of nuts and bolts, screwed fasteners, welding joints and riveted joints. (2)

3. 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.
(10)

Suggested Books:

1. Ajit Singh, Machine Drawing (including Auto CAD), Tata McGraw Hill.
2. N.D. Bhatt, Machine Drawing, Charotar publications.
3. N. Sidheshwar, Machine Drawing, Tata McGraw Hill.
4. P.S. Gill, Machine Drawing, BD Kataria and Sons.
5. V. Lakshmi Narayanan and Mathur, Text-book of Machine Drawing.

BTME-304 Applied Thermodynamics-I

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

L T P
3 1 0

Course Objective: 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

1. Introduction to IC Engines

Introduction to gas power cycles (otto cycle, diesel cycle, dual cycle and its comparison) 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 carburetor, 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. (8)

2. Properties of Steam and Steam Generators

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. Combustion Equations (Stoichiometric and non-Stoichiometric) 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; Boiler performance: equivalent evaporation, boiler efficiency, boiler trial and heat balance; Types of draught and Calculation of chimney height. (9)

3. 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. (7)

4. 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. (4)

5. Steam Turbines

Classification; Simple Impulse v/s Reaction turbine, De Laval Turbine: Compounding of 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, Multistaging of Impulse turbine, condition for axial discharge; relative efficiency 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. (8)

6. 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. (4)

Suggested Books:

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

BTME-305 Manufacturing Processes-I

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

L T P
4 0 0

Course Objective: 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.

1. Introduction

Classification of manufacturing processes, selection criteria for manufacturing processes, general trends in manufacturing**.** (4)

2. 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. (17)

3. Welding Processes

Introduction and classification of 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, metal transfer in arc welding. 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. (17)

4. 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. (10)

Suggested Books:

1. A. Manna, A Textbook of Manufacturing Science and Technology, PHI Publishers.
2. H.S. Shan, Manufacturing Processes, Vol.I. , Pearson Publishers.
3. P. N. Rao, Manufacturing Technology, Foundry, Forming & Welding, Tata McGraw Hill.
4. R.S. Parmar ,Welding Engineering & Technology, Khanna Publishers.
5. Serope Kalpakjian and Steven R. Schmid, Manufacturing Engineering and Technology, Pearson Publishers.
6. Mikell P. Groover Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, 5th Edition.
7. W.A.J. Chapman, Workshop Technology (Part-1,2,3), CBS Publishers & Distributors.

BTME-306 Engineering Materials & Metallurgy

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

L T P
3 0 0

Course Objective: 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, phase diagrams and deformation. They will also be able to understand the materials and their applications which are useful for design and control of heat treating processes

1. 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: point defects, line defects and dislocations, interfacial defects, bulk or volume defects. Solidification of crystalline materials: Nuclei formation , critical radius, Grain growth. Diffusion: diffusion mechanisms, steady-state and nonsteady-state diffusion, factors affecting diffusion. Theories of plastic deformation, Slip and Twinning, recovery, re-crystallization. (10)

2. Phase Transformation
General principles of phase transformation in alloys, phase rule and equilibrium diagrams, Equilibrium diagrams of Binary systems: Gibbs Phase rule, Lever rule, Eutectic and Eutectiod system, Peritectic and Pertectiod system. Transformations Iron carbon equilibrium diagram and various phase transformations. Time temperature transformation curves (TTT curves): fundamentals, construction and applications. (12)

3. 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. (14)

4. Materials
Ferrous Metals and their Alloys, effect of alloying elements (Si, Mn, Ni, Cr, Mo, W, Al) on the structures and properties of steel. Nomenclature of steels and Aluminum alloy. Introduction to Bio-materials and Nano-materials. (4)

Suggested Books:
1. William D. Callister, Materials Science And Engineering: An Introduction, John Wiley & Sons.
2. Sidney H Avner, Introduction to Physical Metallurgy, Tata Mcgraw-Hill.
3. Raghavan, Physical Metallurgy: Principles and Practice, PHI Learning.
4. L Krishna Reddy, Principles of Engineering Metallurgy, New Age International.

BTME-307 Engineering Materials & Metallurgy Lab

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

L T P
0 0 2

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, aluminum and hardened steel specimens.
5. Study of the microstructure of prepared specimens of mild steel, Aluminum 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

Internal Marks: 30	**L T P**
External Marks: 20	**0 0 2**
Total Marks: 50	

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 determine the deflection of beams of different types.

BTME-309 Applied Thermodynamics Lab

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

L T P
0 0 2

1. Study of construction and operation of 2 stroke and 4 stroke Petrol and Diesel engines using actual engines or models.

2. Study of working, construction, mountings and accessories of various types of boilers.

3. To perform a boiler trial to estimate equivalent evaporation and efficiency of a fire tube/ water tube boiler.

4. 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.

5. Determine the brake power, indicated power, friction power and mechanical efficiency of a multi cylinder petrol engine running at constant speed (Morse Test).

6. 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.

7. 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.

8. Study of working, construction and operation of a Multi Stage Reciprocating Compressor.

Fourth Semester

BTME-401 Strength of Materials-II

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

L T P
4 1 0

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.

1. 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. (8)

2. Theories of Failure
Maximum principal stress theory, maximum shear stress theory, maximum principal strain theory, total strain energy theory, shear strain energy theory. Coulomb-Mohr theory. Graphical representation and derivation of equation for these theories and their application to problems related to two dimensional stress systems. (5)

3. 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. (7)

4. Thin Cylinders and Spheres
Calculation of Hoop stress, longitudinal stress in a cylinder, , change in diameter, length and internal volume, effects of joints. Principal stresses in sphere, change in diameter and internal volume. (4)

5. 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. (7)

6. Bending of Curved Beams
Calculation of stresses in cranes or chain hooks, rings of circular and trapezoidal section, and chain links with straight sides. (6)

7. Shear stresses in Beams
Shear stress distribution in rectangular, circular, I, T and channel section; built up beams. Shear centre and its importance. (6)

8. Rotational Discs

Stresses in rotating discs and rims of uniform thickness; disc of uniform strength. (5)

Suggested Books:

1. D.S. Bedi, Strength of materials, Khanna book publishing company.
2. G.H. Ryder, Strength of materials, Macmillan India Ltd.
3. R.S Lehri and A.S. Lehri, Strength of materials, vol. 2, S. K. Kataria and Sons.
4. S.S.Rattan, Strength of materials, Tata McGraw Hills.
5. Timoshenko and Gere, Mechanics of materials, CBS publishers.
6. James M Gere, Mechanics of Materials, Thomson Brooks/Cole/Pearson, 2006.
7. R.C. Hibbeler, Mechanics of Materials, 6th Edition, Pearson Education, 2007.

BTME-402 Theory of Machines-II

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

L T P
4 1 0

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.

1. 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. (8)

2. 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. (8)

3. 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. (6)

4. 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. (8)

5. 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. (4)

6. 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. (4)

7. Kinematic Synthesis of Mechanism
Freudenstien equation, Function generation errors in synthesis, two and three point synthesis, Transmission angles, least square techniques. (4)

Suggested Books:

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

BTME-403 Fluid Mechanics

Internal Marks: 60 **L T P**
External Marks: 40 **4 1 0**
Total Marks: 100

Course Objective/s and Outcome/s: This course is designed for the undergraduate mechanical engineering students to develop an understanding of the behaviour 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.

1. 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), Vapor pressure, compressibility, bulk modulus, Mach number, surface tension and capillarity; Newtonian and non-Newtonian fluids. (4)

2. 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. (8)

3. 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. (8)

4. 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. (8)

5. 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. (8)

6. 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. (8)

7. Pressure and Flow Measurement

Manometers; Pitot tubes; various hydraulic coefficients; Orifice meters; Venturi meters; Borda mouthpieces; Notches (rectangular, V and Trapezoidal) and weirs; Rotameters. (4)

Suggested Books:

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

BTME-404 Applied Thermodynamics-II

Internal Marks: 60 **L T P**
External Marks: 40 **4 1 0**
Total Marks: 100

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.

1. 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. (4)

2. 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.(4)

3. 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. (4)

4. Thermodynamics of Dynamic Rotary Compressors
Applications of Steady Flow Energy Equation and thermodynamics of dynamic (i.e., centrifugal and axial flow m/c's) 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. (6)

5. 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. (6)

6. 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. (6)

7. 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. (8)

8. 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 consumption; 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. (8)

Suggested Books:

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

BTME-405 Manufacturing Processes-II

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

L T P
3 0 0

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.

1. Machine Tools

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. (12)

2. 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. (12)

3. 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 simple 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. (16)

Suggested Books:

1. W.A.J. Chapman, Workshop Technology (Part -1,2,3), CBS Publishers & Distributors.
2. M. P. Groover, Fundamentals of Modern manufacturing, Wiley
3. Serope Kalpakjian and Steven R. Schmid, Manufacturing Engineering and Technology, Pearson Publishers.
4. B. L. Juneja and G. S. Sekhon, Fundamentals of Metal Cutting & Machine Tools, New Age International (P) Ltd.
5. H.S. Shan, Manufacturing Processes, Vol. I&II, , Pearson Publishers
6. PC Sharma, A Text Book of Production Technology, S. Chand & Company Ltd.

BTME-406 Fluid Mechanics Lab

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

L T P
0 0 2

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

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

L T P
0 0 2

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 on tool and cutter grinder.
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

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

L T P
0 0 2

1. To draw displacement, velocity & acceleration diagram of slider-crank and four bar mechanism at any instant.
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.

Fifth Semester

BTAM-500 Engineering Mathematics-III

		L	T	P
Internal Marks:	**40**			
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

Course Objective: To make students familiar with some specific mathematical concepts and tools to understand and analyse the mechanical engineering problems. The exposure of these tools will enhance the analytical ability to deal with engineering problems.

1. Fourier Series: Periodic functions, Euler's formula. Even and odd functions, half range expansions, Fourier series of different wave forms. (6)

2. Laplace Transforms: Laplace transforms of various standard functions, properties of Laplace transforms, inverse Laplace transforms, transform of derivatives and integrals, Laplace transform of step function, impulse function, periodic functions, applications to solution of ordinary linear differential equations with constant coefficients, and simultaneous differential equations. (7)

3. Special Functions: Power series solution. of differential equations, Frobenius method, Legendre's equation, Legendre polynomial, Bessel's equation, Bessel functions of the first and second kind. Recurrence relations, equations reducible to Bessel's equation. (7)

4. Partial Differential Equations: Formation of partial differential equations, Linear partial differential equations, homogeneous partial differential equations with constant coefficients. (7)

5. Applications of PDEs: Wave equation and Heat conduction equation in one dimension. Two dimensional Laplace equation in Cartesian Coordinates, solution by the method of separation of variables. (7)

6. Functions of Complex Variable: Limits, continuity and derivative of the function of complex variable, Analytic function, Cauchy-Riemann equations, conjugate functions, harmonic functions; Complex Integration: Line integrals in the complex plane, Cauchy's theorem, Cauchy's integral formula and derivatives of analytic function. (4)

Suggested Books:

1 Kreyszing, E., Advanced Engineering Mathematics, Eighth edition, John Wiley, New Delhi
2 Grewal, B. S., Higher Engineering Mathematics, Khanna Publishers, New Delhi
3 Ian N. Sneedon, Elements of Partial Differential Equations, McGraw- Hill, Singapore, 1957
4 Peter. V. O'Nil, Advanced Engineering Mathematics, Wadsworth Publishing Company
5 Taneja, H. C., Engineering Mathematics, Volume-I & Volume-II, I. K. Publisher
6 Babu Ram, Advance Engineering Mathematics, Pearson Education
7 Bindra, J. S., Applied Mathematics, Volume-III, Kataria Publications
8 Advanced Engineering Mathematics, O'Neil, Cengage Learning

BTME-501 Design of Machine Elements-I

		L	T	P
Internal Marks:	**40**	**4**	**2**	**0**
External Marks:	**60**			
Total Marks:	**100**			

Course Objective: The course is intended to understand mechanical design, design process, design ethics, codes and standards, design considerations, preferred size, fracture mechanics, material selection, and various considerations like manufacturing, safety etc., which are applied in design. The focus is on blending fundamental development of concepts with practical specification of components. The failure prevention by static and dynamic loading and the design of mechanical elements constituting temporary or permanent joints, shafts, keys, couplings, levers and pipe joints are understood in this course. After the study, students are expected to design the suitable joint for a desired load; and design a shaft, key and coupling for a specified power transmission.

1. Introduction to Mechanical Design

Meaning of mechanical design, conceptual design, design process, design tools and resources, professional responsibilities of a design engineer, standards and codes, general design considerations, economic considerations, manufacturing considerations, safety and product liability, stress and strength, factor of safety, reliability, dimension and tolerances, concurrent design concept, design for X. (5)

2. Material Selection for Design

Designation of materials, mechanical properties of materials, materials selection using Ashby charts. (4)

3. Load, Stress and Deflection Analysis

Equilibrium and free body diagram, review of the basics of mechanics of solids, concept of tearing, bearing, shearing, crushing, bending and fracture, stress concentration, contact stresses, deflection and stiffness. (6)

4. Failures Resulting from Static Loading

Static strength, failure theories for ductile and brittle materials, introduction to fracture mechanics. (4)

5. Fatigue Failures Resulting from Variable Loading

Fatigue in metals, approach to fatigue failure in analysis and design, low cycle and high cycle fatigue, stress-life method, endurance limit and fatigue strength, endurance limit modifying factors, stress concentration and notch sensitivity. Characterizing fluctuating stresses, fatigue failure criteria under fluctuating stresses, torsional fatigue strength under fluctuating stresses, combination of loading modes, cumulative fatigue damage. (6)

6. Design of Permanent Joints

Design of rivets and welds under various loading conditions. (5)

7. Design of Non-Permanent Joints

Threaded fasteners, bolted joint analysis under external load, bolted joint under eccentric loading, bolted joint under fluctuating load, design of pipe joints with oval flange, square flange, design of spigot and socket cotter joint, gib and cotter joint, knuckle joint. (8)

8. Design of Shafts, Keys and Couplings

Design of solid and hollow shafts, design of shaft for rigidity, design of axle. Design of keys, splines. Design of sleeve and solid muff coupling, clamp or compression coupling, rigid and flexible flange coupling. (6)

9. 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. (4)

10. 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. (4)

Suggested Books:

1. V.B Bhandari, Design of Machine elements, Tata McGraw Hill
2. Joseph E. Shigley, Charles Russell Mischke, Richard Gordon Budynas, Mechanical Engineering Design, McGraw-Hill
3. Robert C. Juvinall and Kurt M. Marshek, Fundamentals of machine component design, John Wiley & Sons
4. Ansel C. Ugural, Mechanical design of machine components, CRC Press

Examination Guidelines: Design data book is allowed. The question paper will be of four hours. There will be eight questions of ten marks each. Candidate will be required to attempt any six questions.

BTME-502 Computer Aided Design and Manufacturing

		L	T	P
Internal Marks:	**40**	**3**	**0**	**0**
External Marks:	**60**			
Total Marks:	**100**			

Course Objective: The course is designed to understand the basic concepts of CAD/CAM, different methods to generate various types of curves and surfaces, solid modeling techniques, transformation of models in CAD environment, features of NC/CNC/DNC machines, part programming of NC machines and Computer Integrated Manufacturing.

1. Fundamentals of CAD/CAM
Introduction to CAD/CAM and its role in product design and development cycle; Design process with and without computer, advanced 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. (6)

2. Geometric Modeling
Need and types of Geometric Modeling: Wireframe, surface and solid modeling; Solid Modeling Techniques: Boundary Representation (B-rep), Constructive Solid Geometry (CSG), Parametric Modeling Technique; Mass and volumetric properties calculations; Concepts of hidden-line removal and shading. (5)

3. Geometric Transformations
Overview of Mathematics preliminaries; matrix representation of 2 and 3 dimensional transformation for translation, scaling, rotation about principal axes, mirror imaging about principal planes, principal axes and origin, Concatenation of transformation matrices. Applications of geometric transformations. (5)

4. Representation of Curves and Surfaces
Non-parametric and parametric representation of curves; Parametric representation of Hermite Cubic Spline, Bezier curves, Uniform and Non-uniform B-spline curves; Surface and its analysis. Representation of Analytical and synthetic surfaces (Bilinear Surface, Coons Surface Patch, Bicubic Surface Patch, Bezier Surface, B-spline surface). (7)

5. NC/CNC/DNC 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 radius compensation; NC motion control system; Direct Numerical Control, Adaptive control in machining system, Combined DNC/CNC system. (4)

6. CNC Part Programming
Basic terminology of Parts programming, Block formats; fixed/floating zero; types and classification of machine codes, Manual part programming; Canned Cycles for CNC lathe and milling machines. (6)

7. Computer Integrated Manufacturing Systems

Basic Concepts of CIM: Definition and Evolution of CIM; Benefits of CIM; Flexible Manufacturing Systems: physical Components of FMS. Types of Flexibility, Layout Considerations; FMS benefits. (3)

Suggested 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. Les A. Piegl, Wayne Tiller, The NURBS Book, Springer
4. Zeid Ibraham, CAD/CAM - theory and Practice, Tata McGraw Hill
5. P. N Rao, CAD/CAM, Tata McGraw Hill
6. Peter Smid, CNC Programming Handbook, Industrial Press Inc

BTME-503 Mechanical Measurements and Metrology

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

L	T	P
3	0	0

Course Objective: This course is designed to provide students with an overview of mechanical measurements, metrology and various measurement standards used in industry. The students will learn the concepts of static and dynamic characteristics of measuring instruments, errors in measuring systems. They will also learn sensors, transducers and various instruments for measurements like pressure, flow, temperature, speed, force, torque and shaft power etc. used in manufacturing or process industry. Upon completion of the course, the students should have the ability to understand the importance of measurement and metrology in the industry and will be able to apply the knowledge gained for the practical applications.

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. (3)

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. (4)

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. (3)

4. Metrology
Line, end and wavelength standards; linear measurements; comparators - their types, relative merits and limitations; Angular measurements - sine bar, clinometer, angle gauge; 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. (6)

5. Functional Elements
Introduction to sensors and transducers; types of sensors; review of electro-mechanical sensors and transducers - variable resistance, inductance and capacitive pickups; photo cells and piezoelectric transducers and application of these elements for measurement of position, displacement, speed, velocity, acceleration, force and liquid level. Resistance strain gauges - gauge factor, bonded and

unbonded gauges, temperature compensation; application of strain gauges for direct, bending and torsional loads. Introduction to amplifying, transmitting and recording devices. (5)

6. Pressure and Flow Measurement

Bourdon tube, diaphragm and bellows, vacuum measurement - Mcleod gauge, thermal conductivity gauge and ionisation gauge; Dead weight gauge tester. Electromagnetic flux meters, ultra-sonic flow meters and hot wire anemometer: flow visualization techniques. (4)

7. Temperature Measurement

Thermal expansion methods - bimetallic thermometers; liquid-in-glass thermometer 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. (4)

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. (4)

9. Data Acquisition

Digital input, digital output, digital to analog and analog to digital converter, low pass filters; Introduction to signal amplification and filtering. (3)

Suggested 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 Publisher
5. B.C Kuo, Automatic Control systems, Prentice Hall
6. M.B. Histand and D.G.Alciatore, Introduction to Mechatronics and Measuremen systems, McGraw Hill, 1998

BTME-504 Fluid Machinery

		L	T	P
Internal Marks:	**40**	**3**	**1**	**0**
External Marks:	**60**			
Total Marks:	**100**			

Course Objective: The course is designed to understand the basic concepts of turbo machines; energy transfer in turbo machines, various types of hydraulic turbines. The concept of Impulse-momentum principal, jet impingement on different types of plates, calculations for force exerted, work done and efficiency of jet, velocity triangles for different runners for different turbines, Understanding the different designs of various runners of turbines, working proportions and design parameters for the runner of Francis and Kaplan turbines and various types of pumps, understanding Electro- Mechanical governing of turbines, Concept of Net Positive Suction Head (NPSH) and its application in determining turbine / pump setting. After the study of this course, a student is expected to analyze practical problems of various types of hydraulic turbines and pumps under working conditions.

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 center and tangentially at one end of the vane; calculations for force exerted, work done and efficiency of jet. Basic components of a turbo machine and its classification on the basis of purpose, fluid dynamic action, operating principle, geometrical features, path followed by the fluid and the type of fluid etc. Euler's equation for energy transfer in a turbo machine and specifying the energy transfer in terms of fluid and rotor kinetic energy changes. (6)

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)

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. (6)

5. **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. (10)

6. **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. (5)

7. **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. (5)

8. **Hydraulic Devices and Systems**

Construction, operation and utility of simple and differential accumulator, intensifier, fluid coupling and torque converter, Air lift and jet pumps; gear, vane and piston pumps, Hydraulic Rams. (5)

Suggested 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-505 Computer Aided Design and Manufacturing Lab

	L	T	P
Internal Marks: 30			
External Marks: 20	**0**	**0**	**2**
Total Marks: 50			

1. To draw 2D sketches including lines, arcs, fillets, chamfer etc.
2. To generate 3D models from 2D sketches.
3. To generate 3D models with holes.
4. To modify existing 3D models.
5. To assemble various 3D models to make an assembly.
6. To write manual part program for machining given part on a CNC lathe.
7. To write manual part program for machining given part on a CNC milling machine.
8. To program on FMS system for machining given part on a CNC lathe and CNC milling machine.
9. To automatically generate CNC part program using CAM software.

BTME-506 Mechanical Measurements and Metrology Lab

		L	T	P
Internal Marks:	**30**			
External Marks:	**20**	**0**	**0**	**2**
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 gauge with the help of a dead weight gauge 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
10. Measurement of strain at the root of Cantilever/simply supported Beam using strain gauges.
11. Data acquisition using Arduino Microcontroller kits.

BTME-507 Fluid Machinery Lab

		L	T	P
Internal Marks:	**30**			
External Marks:	**20**	**0**	**0**	**2**
Total Marks:	**50**			

1. Determination of various efficiencies of Hydraulic Ram.
2. To draw characteristics of Francis 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.

Note: The students should visit any Hydroelectric Power Station.

BTME-951 Industrial Safety and Environment

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

L	T	P
3	0	0

Course Objective: The course is designed to understand the basic concepts of safety practices followed in the industry. It will helpful to understand the basic principles of Safety practices, estimate the risk level of a given hazardous area. To apply and adopt safety management and policy, carryout accident analysis and to understand basics of environmental and its impact on industrial organizations.

1. Meaning and Need for safety:
Relationship of safety with plant design, equipment design and work environment. Industrial accidents, their nature, types and causes. Assessment of accident costs; prevention of accidents. Industrial hazards, Hazard identification techniques, Accident investigation, reporting and analysis. (4)

2. Planning for Safety and its Measures: Definition, Purpose, Nature, Scope and Procedure, Range of Planning, Variety of Plans, Policy Formulation and Implementation of Safety Policies. (4)

3. Safety Measures: Safety Measures in a Manufacturing Organization, Safety and Economics, Safety and Productivity, Employees Participation in Safety. Safety Standards and Legislation. (4)

4. Heat Control and Ventilation:
Environmental Factors in Industry, Need of Environment Control, Effect of Temperature, Heat stresses, Physiology of Heat Regulation, Thermal Environment, Measurement of thermal environment, Thermal comfort, Thermal limits for comfort, Thermal comfort indices, Thermal limit for comfort, Control of Heat exposer. Purpose of Ventilation, Natural Ventilation, Mechanical Ventilation, Air Conditioning Process Ventilation; Control of Heat Exposures: Control at Source, Insulation, and Local Exhaust Ventilation. Control of Radiant Heat, Dilution Ventilation, Local Relief, (8)

5. Industrial Lighting:
Introduction to Illumination, Purpose of Lighting, Benefits of Good Illumination. Source lighting, types of Artificial Lighting, Principles of Good Illumination, Terms used in illuminations, Recommended Optimum Standards of Illumination, Design of Lighting Installation, Maintenance Standards Relating to Lighting and Colour. (8)

6. Noise and Vibrations: Introduction, Type of Noise: Continuous and Impulse Noise, Measurement and Evaluation of Noise, Source of Noise, Effect of Noise and Vibrations on Human Body and Mind, Noise control and Isolation, Noise Absorption Techniques, Silencers for Noise. Measurement of Vibration, Effect of Vibration, Measurements to control vibration.
Nature of Fatigue, Measurement and Mitigation of Physical and Mental Fatigue. (8)

Suggested Books:

1. Tarafdar Nishith K., Industrial Safety Management, Dhanpat Rai & Co.
2. Prashar and Bansal, Industrial Safety & Environment, S. K. Kataria & Sons.
3. Leo Beranek L., Noise Reduction, Peninsula Pub.
4. Russell De Reamer, Modern Safety and Health Technology, John Wiley & Sons.
5. Firenze Robert J., The Process of Hazard Control, Kendall Hunt Pub Co.
6. Heinrich, Industrial Accident Prevention, McGraw Hill.
7. Joselin Edward L., Ventilation, E. Arnold.

BTME-952 Energy Conservation and Management

Internal Marks: 40	**L**	**T**	**P**
External Marks: 60	**3**	**0**	**0**
Total Marks: 100			

Course Objective: The course is formulated to understand the basic knowledge of different terms & principles of energy conservation, audit and management, evaluation of the energy saving & conservation in different mechanical utilities. It will also enable to understand efficient heat & electricity utilization, saving and recovery in different thermal and electrical systems and to prepare energy audit report for different energy conservation instances.

1. Energy Scenario
Classification of energy resources, Indian energy scenario, Energy consumption pattern (domestic, industrial and other sectors), Energy needs of growing economy, Energy intensity, Energy pricing, Energy security, Energy conservation and its importance, Future energy strategy. (3)

2. Energy Conservation Act 2001 and Related Policies
Energy conservation Act 2001 and its features, Notifications under the Act, Schemes of Bureau of Energy Efficiency (BEE) including designated consumers, State designated agencies, Electricity Act 2003. Integrated energy policy, National action plan on climate change, ECBC code for building construction. (3)

3. Financial Management and Energy Monitoring & Targeting
Investment need, Appraisal and criteria, Financial analysis techniques, Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flow, Risk and sensitivity analysis, Financing options, Energy performance, Contracts and role of Energy Service Companies (ESCOs), Elements of monitoring & targeting, Data and information analysis techniques-energy consumption and production, cumulative sum of differences (CUSUM), Energy Management Information Systems (EMIS). (6)

4. Energy Management and Audit
Need and types of energy audit, Energy management (audit) approach-understanding energy costs, bench marking, energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments and metering. (6)

5. Energy Efficiency in Thermal Utilities
Boilers: Performances evaluation, analysis of losses, feed water treatment, blow down, energy conservation opportunities, boiler efficiency, soot blowing, soot deposit reduction, reasons for boiler tube failures, start up, shut down and preservation. Steam Properties: Assessment of steam distribution losses, steam leakages, steam trapping. condensate and flash steam recovery system, identifying opportunities for energy savings. Furnaces: General fuel economy measures in furnaces, excess air, heat distribution, temperature control, draft control, waste heat recovery. Insulation and refractories: Insulation types and application, economic thickness of insulation, heat savings and application criteria,

Refractory types, selection and application of refractories, heat loss. Waste Heat Recovery: Classification, advantages and applications, commercially viable waste heat recovery devices, saving potential. Cogeneration: Need, application, advantages, classification, saving potentials, heat balance, steam turbine efficiency, tri-generation, micro turbine. Factors affecting refrigeration and air conditioning system performance and savings opportunities. Performance assessment of window and split room air conditioners. Star labeled pumps. (14)

6. Energy and Environment

United Nations Framework Convention on Climate Change (UNFCC). Sustainable development. Kyoto Protocol. Conference of Parties (COP). Clean Development Mechanism (CDM)-Bachat Lamp Yojna and industry. Carbon credits. (4)

Suggested Books:

1. Dale R Patrick, Stephen W Fardo, Energy Conservation Guidebook, 2nd Edition, CRC Press.
2. Albert Thumann, Handbook of Energy Audits, 6th Edition, The Fairmont Press.
3. Bureau of Energy Efficiency Reference Book: No.1, 2, 3 4.
4. W.C. Turner, Energy Management Handbook, John Wiley and Sons.
5. J. Krieder and A. Rabl, Heating and Cooling of Buildings-Design for Efficiency, McGraw Hill Publication.
6. S.C. Arora and S. Domkundwar, Power Plant Engineering, Dhanpat Rai & Co. (P) Ltd.
7. P.K.Nag, Plant Engineering, Tata McGraw Hill.
8. S.K. Soni and Manoj Nair, Energy Management, Satya Parkashan.

Sixth Semester

BTME 601 Design of Machine Elements-II

		L	T	P
Internal Marks:	**40**	**4**	**2**	**0**
External Marks:	**60**			
Total Marks:	**100**			

Course Objective: The course is intended to design the various elements of transmission drive, which includes frictional drive, chain drive, gear drive, bearings, flywheel, brakes and clutches and springs. The focus is on blending fundamental development of concepts with practical specification of components. After the study, students are expected to select/design various transmission elements used in a machine.

1. Transmission Drives

Belt 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. (5)

Chain Drives: basics, Roller chains, polygonal effect, power rating, and selection of chain drive. (2)

Gear drives: Standard system of gear tooth and gear module, gear tooth failure, strength of gear tooth, Force analysis–spur gearing, helical gearing, bevel gearing, worm gearing. AGMA code and Buckingham analysis based design of spur and helical gear. (14)

2. Bearings

Slider Bearing: Principle of hydrodynamic lubrication, modes of lubrication, Reynolds equation, bearing performance parameters, slider bearing design. (5)

Roller Bearing: 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. (5)

3. Design of Flywheel

Introduction, Energy stored in a flywheel, stresses in a rim, design considerations. (4)

4. Clutches

Design of contact clutches i.e. plate, multi-disc, cone and centrifugal clutches. (4)

5. Brakes

Design of band, disc, block with shoe and internal expanding brakes. (3)

6. System design

Students are required to submit project on the assembled system as a complete assignment which should include (a) component design, (b) assembly design, (c) bill of material (d) estimation and costing. The project should preferably be on design software (solid modeling).

Suggested Books:

1. V.B. Bhandari, Design of Machine elements, Tata McGraw Hill

2. Joseph E. Shigley, Charles Russell Mischke, Richard Gordon Budynas, Mechanical Engineering Design, McGraw Hill
3. Robert C. Juvinall and Kurt M. Marshek, Fundamentals of machine component design, John Wiley& Sons
4. Ansel C. Ugural, Mechanical design of machine components, CRC Press

Examination guidelines: Design data book is allowed. The question paper will be of four hours. There will be eight questions of ten marks each. Candidate will be required to attempt any six questions.

BTME-602 Industrial Automation and Robotics

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

L	T	P
4	0	0

Course Objective: The course is designed to understand the basic concepts of automation, low cost automation, design of pneumatic and hydraulic circuits and their elements, fluidics, electrical and electronic controls, transfer devices and feeders and robotics.

1. Introduction:
Concept and scope of automation: Socio economic impacts of automation, Types of Automation, Low Cost Automation. (4)

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. (8)

3. Fluidics:
Boolean algebra, Truth Tables, Logic Gates, Tesla's Tube, Coanda effect and devices based on its effect. (6)

4. 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, Basics of Control, Chain Circuit Hydraulic & pneumatic circuits using time delay valve & quick exhaust valve, Speed Control of a cylinder, Layouts and designation of specific elements in a circuit. (10)

5. Electrical and Electronic Controls
Basics of Programmable logic controllers (PLC), Architecture and components of PLC, Ladder logic diagram. (5)

6. Transfer Devices and feeders:
Classification, Constructional details and applications of transfer devices, Vibratory bowl feeders, Reciprocating tube, Centrifugal hopper feeders. (5)

7. Robotics
Introduction, Classification based on geometry, control and path movement, Robot Specifications, Robot performance parameters. Coordinate frames, Translation and rotation, Composite homogenous transformations, kinematic parameters, Denavit-Hartenberg (D-H) representation, Robot Programming, Teach pendants, Machine Vision: Image representation, shape analysis, segmentation iterative processing, Industrial Applications of Robots. (10)

Suggested 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. Robert J Schilling, Fundamentals of Robotics, Pearson Education

BTME-603 Statistical and Numerical Methods in Engineering

		L	T	P
Internal Marks:	**40**	**3**	**1**	**0**
External Marks:	**60**			
Total Marks:	**100**			

Course Objective: The course is formulated with aim of reviewing the basic statistical techniques (central tendency and dispersion) with probability and sampling distributions to analyze the significance difference in fit from mean and variance of the measured data of system. Solution of algebraic/transcendental equation; linear system of equations, ordinary and partial differential equations is a key objective of this course. This course will also help the student to interpolate the data on the basis of its trend and to estimate the differential and integration of integrand.

1. Introduction
Review of data array, frequency distribution construction and graphic representation, mean, median, mode and standard deviation, probability and probability distribution, conditional probability, random variables. (4)

2. Probability Distributions and Sampling Distributions
Poisson, Normal and Binomial distributions; Fundamentals of sampling, large samples, small samples; Normal sampling distributions, sampling distribution of the means, t-distribution, F-distribution, Chi-square distribution. (8)

3. Error in Numerical Calculations
Errors and their analysis, general error formula, errors in a series approximation. (2)

4. Solution of Algebraic and Transcendental Equations
Bisection method, iteration method, method of false position, Newton-Rapson method, solution of systems of non linear equations. (4)

5. 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. (5)

6. 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). (5)

7. Solution of Linear Systems of Equations
Gauss Elimination method (fall and banded symmetric and unsymmetrical systems), Gauss Jordon method, Eigen value problems (Power method only). (4)

6. Numerical Solution of Ordinary and Partial Differential Equations

Solution by Taylor's series, Prediction-correction method, Boundary value problems, Euler's and modified Euler's method, Runge-Kutta method, finite difference methods. Finite difference approximation to derivatives, Solution to Laplace equation- Jacobi's method, Gauss–Siedel method. (10)

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

Suggested Books:

1. S. S. Sastry, Introductory Methods of Numerical Analysis, Prentice Hall of India.
2. V. Rajaraman, Computer Oriented Numerical Methods, Prentice Hall of India.
3. S.D. Conte, Cari De Boor, Elementary Numerical Analysis, McGraw Hill.
4. B. Carnahan, Applied Numerical Methods, John Wiley.
5. Richard I. Levin, S. David., Rubin Statistics for Management, Pearson.
6. Clave Moler, Experiment with MATLAB, www.mathworks.com

BTME-604 Automobile Engineering

		L	T	P
Internal Marks:	**40**	**3**	**0**	**0**
External Marks:	**60**			
Total Marks:	**100**			

Course Objective:
The course is formulated to broaden the understanding of the students about the fundamental concepts of the vehicles Chassis, Fuel supply system, Lubrication, Cooling, suspension, transmission, steering, braking and electric systems. It is also to develop the ability of the students to identify the causes and remedies of the problem in automobiles to enhance the performance characteristics of the engines and to identify the method to improve the performance of the engines.

1. Introduction
Basic structure, general layout and type of automotive vehicles, Frameless and unitary construction; position of power unit. Loads on the frame, considerations of strength and stiffness, engine mounting.(2)

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. Introduction to new technology; battery/trolley bus, hybrid and its types. (4)

3. Fuel Supply System
Air cleaner and fuel pumps; Air fuel requirements and carburetion; starting, running, idling and accelerating conditions; constructional details of carburetors and fuel injection systems, Diesel fuel system - cleaning, injection pump, injector and nozzles, MPFI, CRDI engines. Introduction to other alternative fuels: CNG, LNG, properties, modification required to use CNG/LNG in engines, performance and emission characteristics of CNG/LNG/Duel fuel supply system. (4)

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. (4)

5. Suspension System
Conventional and independent suspension systems; shock absorbs and stabilizers, electronically controlled suspension, Adaptive suspension, Active suspension systems; Wheels and Tyres. (4)

6. Transmission system
Basic requirements and standard transmission systems; constructional features of automobile clutch, gear box, differential, limited slip differential, front and rear axles; overdrives, propeller shaft, universal joint and torque tube drive, Rear wheel vs front wheel drive, principle of automatic transmission. (4)

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. (4)

8. Braking System

General braking requirements, Mechanical, hydraulic, vacuum power and servo brakes, Weight transfer during braking and stopping distances, Antilock Braking System (ABS) (4)

9. Electric System

Conventional (coil and magneto) and transistorized ignition systems; Charging, capacity ratings and battery testing; starter motor and drive arrangements: voltage and current regulation. (4)

10. Maintenance

Preventive maintenance, trouble shooting and rectification in different systems, engine tuning and servicing. (2)

Suggested Books:

1. Crouse WH, Automotive mechanics, McGraw Hill Publishing Co.
2. Heitner J, Automotive Mechanics, East West Press.
3. Kirpal S, Automobile Engineering Vol I and II, Standard Publishers.
4. Giri NK, Automobile Technology, Khanna Publishers.
5. Rajpoot RK, Automobile Engineering, Laxmi Publishers.
6. Gupta RB, Automobile Engineering, S.K. Katria.
7. Chhikara A, Automobile Engineering I,II & III, Satya Prakashan.

BTME-605 Industrial Automation and Robotics Lab

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

L	T	P
0	0	2

1. Design and assembly of basic hydraulic / pneumatic circuit.
2. Demonstration and working of power steering mechanism.
3. Design of hydraulic / pneumatic circuit for automatic reciprocating movement of double acting cylinder using appropriate direction control valves.
4. Design of hydraulic / pneumatic circuit for clamping by using appropriate direction control valve and pressure control valves.
5. Design of hydraulic / pneumatic circuit for punching holes in a strip including automatic clamping, feeding and punching operations.
6. Programming of a robot for pick and place operations.
7. Programming of a PLC using ladder diagram.

BTME-606 Automobile Engineering Lab

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

L	T	P
0	0	2

1. Demonstration of valve re-facing 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.

5. Trouble shooting in braking system with specific reference to master cylinder, brake shoes and the adjusting of the system.

6. Transmission system including clutches, gear box assembly and differential.

7. Demonstration of fuel supply system for petrol and diesel fuels.

Note: A visit to nearby automobile industry.

BTME-911 I.C. Engines

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

L	T	P
3	0	0

Course Objective: The course is advanced level course of IC Engines and deals with the analysis of engine processes.

1. Introduction to IC Engines
Introduction and historical perspective of IC engines. (2)

2. Thermodynamic Analysis of IC Engines Cycle
Properties of working fluid, thermodynamic charts, unburned mixture charts, burned mixture, fuel air cycle analysis, real cycles, availability analysis of engine processes. (6)

3. Gas Exchange Processes
Inlet and exhaust processes in the four stroke cycle, volumetric efficiency, quasistatic and dynamic effects, flow through valves. Scavenging in the two-stroke cycle engines, scavenging parameters and models, actual scavenging processes, flow through ports. Supercharging and turbocharging, basic relationships, compressors, turbines characteristics, matching of compressor, turbines and engine characteristics. (6)

4. Fuel Metering and Manifold Phenomena in SI Engines
SI Engine mixture requirements, fuel injection systems, feedback systems, flow past throttle plate, flow in inlet manifolds. (5)

5. Combustion in SI Engines
Essential features of the process, thermodynamic analysis of SI engine combustion, combustion process characterization, cyclic variations in combustion. (5)

6. Combustion in CI Engines
Essential features of process, types of diesel combustion systems, phenomenological model of compression – ignition engine combustion. Fuel spray behavior, spray structure, atomization, spray penetration droplet size distribution, spray evaporation, ignition delay. (6)

7. Pollutant Formation and Control
Nature and extent of problem, Nitrogen oxides. Kinetics of NO formation, NOx formation in spark-ignition engines, NOx formation in CI engines. Carbon monoxide, unburned hydrocarbon emissions. Particulate emissions exhaust gas treatment, catalytic converters, three way catalysts, particulate traps. (6)

Suggested Books:

1. John B. Heywood, Internal combustion engine fundamentals McGraw-Hill.
2. V. Ganesan, Internal Combustion Engines, Prentice Hall.
3. V. M. Damundwar, A Course in Internal Combustion Engines, Dhanpat Rai.

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.

BTME-912 Non-Conventional Energy Resources

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**0**	**0**
Total Marks:	**100**			

Course Objective: This course is designed to understand the need and use of various types of non-conventional energy resources. The objective of this course is to inculcate the capacity and capability in the young engineers for doing the calculations in order to design various types of engineering systems for using the non-conventional energy resources.

1. Introduction

Energy scenario, Non-conventional energy resources and their classification, availability and growth in India, Energy consumption as a measure of nation's development, Strategy for meeting the future energy requirements. (3)

2. Solar Energy

Sun as source of energy, Solar energy data of India, Spectral distribution of solar radiation, Depletion of solar radiation, Beam and diffuse radiation, Solar time, Earth-sun angles, Measurement of solar radiation, Principle, general description and design procedures of flat plate and concentrating collectors, General description of solar ponds, Solar refrigeration and air-conditioning, Solar water desalination and water pumping, General description of solar thermal power plants, Solar photovoltaic cells and general description of SPV power plants, Solar energy storage systems, Economic analysis of solar energy systems, Applications of solar energy, Solar energy program in India. (10)

3. Wind Energy

Principle of wind energy conversion, Wind energy data of India, Estimation of power in wind, Classification of wind energy conversion systems, Working and design consideration of different types of wind energy conversion systems, Analysis of aerodynamic forces acting on wind mill blades, Power output and efficiency of wind machines, Applications of wind energy, Site selection considerations, Wind energy program in India. (7)

4. Bio-Mass Energy

Resources of bio-mass energy, Photo-synthesis, Bio-mass energy conversion processes, Bio-mass gasification and liquefaction, Types and working of cow dung based bio-gas plants, Fuel properties of bio-gas, Landfill gas collection system, Applications of bio-mass energy, Bio-mass energy program in India. (6)

5. Geothermal, Tidal and Wave Energy

Origin of geothermal energy, General description of geothermal energy systems, Tidal energy resources in India, General description of single basin and double basin tidal energy conversion systems, Energy from ocean waves, General description of wave machines, Applications of geothermal, tidal and wave energy. (5)

6. Direct Energy Conversion Systems

Magneto Hydrodynamic (MHD) Power Generator, Gas conductivity and MHD equations, Working principle, Types and working of MHD power generators, Thermo-electric Power Generators, Thermo-electric effects and materials, Types and working of thermo-electric generators, Thermo-electric refrigeration, Thermionic Power Generators, Thermionic emission and materials, Fuel Cells, Working principle of a fuel cell, Types and working of fuel cells. (5)

Suggested Books:

1. B.H. Khan, Non-Conventional Energy Resources, McGraw Hill Education (India) Pvt. Ltd.
2. H.P. Garg and Jai Prakash, Solar Energy-Fundamentals and Applications, Tata McGraw Hill.
3. S.P. Sukhatme, Solar Energy-Principles of Thermal Collection and Storage, Tata McGraw Hill.
4. John A. Duffic and W. A. Beckman, Solar Engineering of Thermal Processes, John Wiley.
5. S. L. Sheldon Chang, Energy Conversion, Prentice Hall.
6. O. M. Bockris and S. Srinivasan, Fuel Cells, McGraw Hill.
7. S. Rao and B.B. Parulekar, Energy Technology, Khanna Publishers.

BTME-913 Operations Research

		L	T	P
Internal Marks:	**40**	**4**	**0**	**0**
External Marks:	**60**			
Total Marks:	**100**			

Course Objective: Operations Research students will be exposed to mathematical, engineering and modeling skills that may be useful for designing and solving complex industrial/social/economic problems using various optimization models like deterministic and probabilistic models, simulations, queuing theory, inventory model, replacements models and network models, etc**.**

1. Introduction

Origin of OR and its role in solving industrial problems: General approach for solving OR problems, Classification of mathematical models: various decision-making environments. (2)

2. Deterministic Models

Formulation of deterministic 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, transportation, assignment and sequencing models, Introduction to goal programming; Solution techniques of linear goal programming problems. (6)

3. Probabilistic Models

Decision making under uncertainty: Maximum and minimum models, Introduction to decision tree. Game theory: Solution of simple two person zero-sum games: Examples of simple competitive situation. (6)

4. Simulation

Concept, general approach and application, Use of Monte-Carlo simulation technique to queuing and inventory problems. (4)

5. Dynamic Programming

Introduction to deterministic and probabilistic dynamic programming, Solution of simple problems. (4)

6. Queuing Theory

Types of queuing situation: Queuing models with Poisson's input and exponential service, their application to simple situations. (4)

7. Replacement Models

Replacement of items that deteriorate, Replacement of items whose maintenance and repair costs increase with time, replacement of items that fail suddenly; replacement of items whose maintenance costs increase with time and value of money also changes, individual replacement policy, group replacement policy. (4)

8. Inventory Models

Classification of inventory control models: Inventory models with deterministic demand, inventory models with probabilistic demand, and inventory models with price breaks. (4)

9. Network Models

Shortest route and traveling sales - man problems, PERT & CPM introduction, analysis of time bound project situations, construction of networks, identification of critical path, slack and float, crashing of network for cost reduction, resource leveling and smoothening. (6)

Suggested 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. Hamdy A. Taha, Operation Research: an Introduction, Prentice Hall

BTME-914 Product Design and Development

		L	T	P
Internal Marks:	**40**	**3**	**0**	**0**
External Marks:	**60**			
Total Marks:	**100**			

Course Objective: The course is designed to understand the basic concepts of product design such as visual design, form and colour and product graphics. The students should also be able to comprehend product detailing and development and various aspects of value engineering which can be used in product design.

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. (7)

2. Form and Colour
Elementary forms, their characteristics and significance in design, form transition, form in relation to ergonomics, material and manufacturing process, colour as an element of design, colour clarification dynamics, interrelation of colours, colours and traditions; Psychological use of colour form and material. (8)

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. (5)

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)

5. Product Development
Definition and objectives, Role of designer in product development. Manufacturing and economic aspects of product development, Product promotions. (6)

6. Value Engineering
Value engineering, concept, advantage and applications. Value, types of values. Value engineering techniques. (6)

Suggested Books:

1. W.H. Mayal, Industrial Design for Engineers, London Llifee Books Ltd.
2. Huchingson R. Dale, New Horizons for Human Factors in Design, McGraw Hill
3. N.L. Svensson, Introduction to Engineering Design, New South Wales University Press
4. R. Matousek, Engineering Design: A systematic Approach, Inderscience Publishers
5. K. J. Mccormick (Ed), Human Factor Engineering, McGraw Hill.

BTME-915 Finite Element Method

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

L	T	P
4	0	0

Course Objective: The course is to intended to evaluate the field variables (stress, temperature, pressure etc.) in a specified domain using finite element method (FEM) as a numerical tool. The basics of FEM, discretization procedure, element types, assembling, implementation of boundary conditions and solution procedure is the objective to be understood in this course. The students are expected to develop proficiency in solving simple structural, vibration and heat transfer related problems.

1. Introduction
General description of the method, summary of the analysis procedure. (2)

2. Discretization of the Domain
Type of elements, location of nodes, number of elements, node numbering scheme. (4)

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. (8)

4. Axi-symmetric Solids Subjected to Axi-symmetric Loadings
Axi-symmetric formulation, FEM using triangular element, problem using boundary conditions. (6)

5. Static Analysis
Plain and three dimensional trusses, assembly of global matrix for the banded and skyline solutions, Beams in various different conditions. (6)

6. Dynamic Analysis
Dynamic equations of motion, consistent mass matrix for truss element, evaluation of Eigen values and eigen vectors. (6)

7. Solution of Finite Element Equations
Direct integration methods, central difference method, Houbolt method, Wilson method, Newmark method, mode superposition method. (8)

Suggested 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.
4. Olek Zienkiewicz, Robert Taylor, J.Z. Zhu, The Finite Element Method: Its Basis and Fundamentals, Elsevier.

BTME-916 Cryogenic Technology

Internal Marks: 40	**L**	**T**	**P**
External Marks: 60	**3**	**0**	**0**
Total Marks: 100			

Course Objective: To impart the students with basic understanding of cryogenics. To give the idea of properties of engineering materials at cryogenic temperatures, cryogenic measurement systems, cryogenic insulation, liquefaction method and application of cryogenics.

1. Introduction:
Meaning of cryogenics, importance of cryogenics studies, thermal, mechanical and electrical properties of engineering materials at cryogenic temperatures, superconductivity and super conducting materials, thermo electric materials, composite materials, and properties of cryogenic fluids. (4)

2. Liquefaction Cycles
Thermodynamics of ideal liquefaction cycles and Joule-Thomson effect, liquefaction of air (Linde and Claude system), liquefaction of hydrogen, liquefaction of helium. (6)

3. Cryogenic Measurement Systems
Temperature measurements by gas and vapour pressure thermometers, pressure measurements, flow measurements, liquid level measurements, fluid quality measurements. (6)

4. Importance of Cryogenic Insulations
Various factors for selection of insulations, various types such as expanded foams, gas filled& fibrous insulation, vacuum insulation, evacuated powder & fibrous insulation, opacified powder insulation, multi-layer insulation, comparison of performance of various insulations. (6)

5. Applications of Cryogenic Systems
Introduction to the phenomenon of superconductivity and its applications, cryogenic in space technology, cryogenics in biology and medicine, food preservation and industrial applications, nuclear propulsions, chemical propulsions. (8)

6. Hazards and Safety
Physical hazards, chemical hazards, physiological hazards, combustion hazards, oxygen hazards, accidents in cryogenic plants & prevention, safety in handling of cryogens, care for storage of gaseous cylinders, familiarization with regulations of department of explosives. (6)

Suggested 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,
4 Cryogenic Fundamentals-Haselden, Academic press New York
5. Cryogenic Technology –R.W. Vance

6. Advance Cryogenic –Bailey, Plenum Press.
7. Cryogenic Engineering –Scott, R.B.

BTME-917 Total Quality Management

		L	T	P
Internal Marks:	**40**	**3**	**0**	**0**
External Marks:	**60**			
Total Marks:	**100**			

Course Objective: The objective of this course is to provide students with an overview of concept of quality and total quality management. The students will learn TQM elements and principles like just in time, total waste elimination, customer satisfaction, quality function development, process management, total employees involvement, problems solving techniques. benchmarking concept, quality system standards and advanced TQM techniques. Upon completion of the course, the students will be able to apply the concept of TQM in industry.

1. Concept and Definition of Quality and Total Quality Management
Definition, concept and salient features of quality, total quality control (TQC) and total quality management (TQM), TQM models, excellence in manufacturing/service, factors of excellence, relevance of TQM and benefits of TQM. (5)

2. Just-in-Time (JIT)
Definition, elements, benefits, effective facility layouts for JIT system, KANBAN system, MRP (Material Requirement planning) vs JIT system, Total waste elimination, POKA YOKE (mistake proofing), 5'S principle of housekeeping, JIDOKA concept, ANDON system, KAIZEN, workers involvement through JIT: JIT cause and effect diagram, JIT implementation. (6)

3. Customer Satisfaction
Customer satisfaction concept, data collection and customer complaint handling, Customer rights and complaint redressal mechanism. (4)

4. Planning Process and Process Management
Policy development and implementation, plan formulation and implementation, factors affecting process management, and quality assurance system. (5)

5. Total Employees Involvement (TEI)
Methods of TEI, Empowering employees, team building, quality circles, reward and recognition, education and training and suggestion schemes. (5)

6. Problems Solving
Defining problem, problem identification and solving process, PDCA cycle and other QC tools. (3)

7. Benchmarking
Definition, concept, process, five phases and types of benchmarking, advantages and criticism of benchmarking. (3)

8. Quality Systems and Advanced Techniques of TQM

Concept of quality system standards: relevance and origin of ISO 9000; Benefits; elements of ISO 9001, ISO 9002, ISO 9003. Introduction to advanced techniques of TQM i.e. design of experiments, failure mode effect analysis and taguchi method. (5)

Suggested 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. Detailed Contents
5. D.D. Sharma, Total Quality Management Principles Practice & Cases, Sultan Chand & Sons

BTME-961 Entrepreneurship

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**0**	**0**
Total Marks:	**100**			

Course Objective: The course is designed to understand the basic concepts of Entrepreneurship. The student will be able to understand and identify investment opportunities through market and demand analysis and will be able to apply concepts of financial management.

1. Concept of Entrepreneurship

Introduction to entrepreneurship, need for promotion of entrepreneurship, entrepreneurship development programmes (EDP), personality characteristics of entrepreneur. (8)

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. (12)

3. Market and Demand Analysis

Information required for market and demand analysis, market survey, demand forecasting, uncertainties demand forecasting. (4)

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. (6)

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, Government schemes for financial assistance. (6)

Suggested 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.

BTME-962 Management Information System

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**0**	**0**
Total Marks:	**100**			

Course Objective: The course is designed to enhance the quality of management by understanding the basic concepts of decision making and importance of management information system (MIS), to plan, implement, control and evaluate the activities of an organisation. The students are expected to understand the sharing of data between entities and its effective storage for quick relevant information for higher growth of system.

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. (8)

2. Management Information Systems

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. (12)

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. (10)

4. Data Base Management Systems

Introduction, data base designing, relational data base management system, introduction to computerized data base management system. (6)

Suggested 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.

BTME-963 Materials Management

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**0**	**0**
Total Marks:	**100**			

Course Objective: To develop the understanding regarding materials management needs, importance to maintain the continuity of production and sales. To exercise the control over materials at minimum cost. To understand the basics of inventory control and maintaining the efficiency of storage department.

1. Introduction

Meaning, definition, functions of materials management, Concept of integrated materials management, Relationship of materials management with other organizational functions. (6)

2. Materials Planning & Budgeting

Need for materials planning, Factors affecting materials planning, Techniques of materials planning, Materials classification, Codification and standardization, Materials budgeting-meaning and need, Techniques of material budgeting. (8)

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. (10)

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. (6)

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. (6)

Suggested Books:

1. M.M. Verma, Materials Management, S. Chand and Co.
2. Gopal Krishnan and Sundaresan, Materials Management - An Integrated Approach, Prentice Hall
3. Donald W. Dobbler and David N. Burt, Purchasing and Materials Management, Tata McGraw Hill
4. M. Starr and D. Miller, Inventory Control, Prentice Hall.

Beant College of Engineering & Technology, Gurdaspur

Seventh Semester

BTME-801 Industrial Engineering

Internal Marks: 40	**L T P**
External Marks: 60	**4 1 0**
Total Marks: 100	

Course Objective: The objective of the course is to expose the students to various Industrial Engineering concepts like Method Study and Time Study etc. for improving the productivity of the system and to set the standard norms of Production and Industrial systems by using various Industrial Engineering tools, Work Measurement and Ergonomics etc.

1. Introduction
Definition and scope of industrial engineering role of an industrial engineer in industry, functions of industrial engineering department and its organization, qualities of an industrial engineer (2)

2. Productivity
Productivity concept and definition: Introduction, definitions of productivity, Productivity measurement, Benefits of higher productivity, Productivity of materials, Productivity of buildings, lands, machines and manpower, Factors contributing to productivity improvement. (5)

3. Work Study
Introduction, basic procedure, prerequisites of conducting a work study. The human factor in application of work study: Introduction, management and supervisor; their role in work study. (4)

4. Method Study
Introduction to method study and the selection of job: Introduction, definition and objective of method study, procedure of method study, Flow and handling of materials: Introduction, plant layout, developing the new layout, the handling of materials, Tools for recording the movement of worker: Introduction, string diagram, flow process chart, man type, travel chart, multiple activity chart, Principles of motion economy, classification of movements, two handed process chart, Simo chart. (9)

5. Work Measurement
Purpose of work measurement, the basic procedure, the techniques of work measurements, Work sampling: Introduction, basic concept and procedure, Time study: rating: Introduction, the quality worker, the average worker, standard rating and standard performance. Predetermined time standards (PTS): Introduction, definition, advantages of PTS system, Criticisms of PTS system, different forms of PTS system, use of PTS system, and application of PTS system. (8)

6. Work Design
Concept of job enlargement, job enrichment and job rotation, effective job design consideration technological and behavioral factors (4)

7. Ergonomics

Introduction to ergonomics, concept of anthropometry, consideration in designing man machine systems with special reference to design of displays and control. (6)

Suggested Books:

1. MartandTelsang, Industrial Engineering and Production Management, S. Chand
2. O.P. Khanna, Industrial Engineering & Management, Dhanpat Rai and Sons
3. ILO, Second Edititon, Work Study, Oxford and IBH

BTME-802 Heat Transfer

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

Course Objective: This course is designed to understand the basic concepts of heat transfer and mathematical analysis for different modes of heat transfer i.e. conduction, convection and radiation. The objective of this course is to inculcate the capacity and capability in the young engineers for doing the calculations in order to design various types of engineering systems involving flow of heat.

1. Introduction
Concept of heat transfer, difference between the subject of "Heat Transfer" and "Thermodynamics", Different modes of heat transfer-conduction, convection and radiation. (2)

2. Conduction
Fourier's law of heat conduction, Coefficient of thermal conductivity, Steady and unsteady heat transfer, Effect of temperature and pressure on thermal conductivity of solids, liquids and gases, Three dimensional general conduction equation in rectangular, cylindrical and spherical coordinates involving internal heat generation and unsteady state conditions, Thermal diffusivity, Derivation of equations for simple one dimensional steady state heat conduction for heat conduction though walls, cylinders and spherical shells (simple and composite), Electrical analogy of the heat transfer phenomenon, Effect 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, Critical thickness of insulation layers on pipe carrying hot fluids. (9)

3. Theory of Fins
Concept of fin, classification of fins and their applications, Heat transfer analysis for straight fins (uniform cross-section like circular and rectangular) having infinite length, tip insulated and convection at the tip, Heat transfer analysis for fin having triangular or trapezoidal profile, Fin performance: fin effectiveness and fin efficiency, Design criteria for fins, Application of fins for temperature measurement of fluid flowing through pipes. (6)

4. Convection
Newton's law of cooling, Free and forced in cartesian co-ordinates 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, Overall heat transfer coefficient, Log mean temperature difference for evaporator and condenser tubes, and parallel/counter flow heat exchangers, Calculation of number and length of tubes in a heat exchanger, Effectiveness of heat exchanger and number of transfer units (NTU), Design criterion for heat exchangers, Concept of heat pipe (theory only). (9)

5. Convection with Phase Change (Boiling and Condensation)
Regimes of pool boiling, Nucleation and different theories of nucleation, Critical heat flux (burn out point), Different phases of forced convection boiling, Condensation and its types, Film wise condensation on a vertical and inclined surface and calculation of local and average heat transfer coefficient. (4)

6. Radiation

Stefan Boltzman's law, Intensity of Radiation, Emissivity, absorptivity, reflectivity and transmissivity, Concept of black and grey bodies, Plank's law of monochromatic radiation, Kirchoff's law and Lambert's Cosine law,Interchange factor and Shape/Geometric factor, Description of radiation density, irradiation, radiosity and radiation shields, Radiation exchange between two bodies using the definition of radiosity and its application to cases of radiation exchange between two and three or three bodies, Error in Temperature measurement by a thermocouple probe due to radiation losses. (8)

Suggested Books:

4. Frank P. Incropera and David P. De Witt, Fundamentals of Heat and Mass transfer, John Wiley.
5. P.S. Ghoshdastidar, Heat Transfer, Oxford Press.
6. D.S. Kumar, Heat & Mass Transfer, S K Kataria& Sons.
7. A.J. Chapman, Heat Transfer, McGraw Hill Book Company, New York.
8. J.P. Holman, Heat Transfer, Tata McGraw Hill Publishing Company Ltd.
9. Yunus A. Cengel, Afshin J. Ghajar, Heat and Mass Transfer-Fundamentals and Applications, McGraw Hill Education Pvt. Ltd.
10. Eckert & Drake, Heat and Mass Transfer, McGraw Hill Book Company, New York.
11. Mahesh M. Rathore, Engineering Heat and Mass Transfer, Laxmi Publications.

BTME-803 Refrigeration and Air Conditioning

	L	T	P
Internal Marks: 40			
External Marks: 60	**3**	**1**	**0**
Total Marks: 100			

Course Objective: To introduce the students the basic refrigeration cycles of various refrigeration systems. To impart the students with basic understanding of and air conditioning systems for different climatic seasons. To give the basic understanding of design aspects of RAC components such as evaporators, condensers, capillary tubes, expansion valve etc.

1. Basic Concepts

Definition of Refrigeration and Air conditioning; Difference between Refrigeration and cooling; Difference between refrigeration and air conditioning; Natural and mechanical refrigeration; Refrigeration effect, cooling capacity, heating effect, heating capacity; Units of refrigeration; Coefficient of performance and Energy Performance Ratio; Single Phase Reversed Carnot cycle and its limitations; Two Phase Reversed Carnot cycle and its limitations; Methods of Refrigeration; Numerical problems.(3)

2. Gas Cycle Refrigeration and Aircraft Refrigeration & Air conditioning

Bell Coleman/Reversed Brayton/ Reversed Joule Cycle and its analysis 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. (4)

3. Vapour Compression Refrigeration Cycle

Modifications of reversed Carnot cycle with vapour as a refrigerant, Vapour compression refrigeration cycle & system; Representation of this cycle on P-V, T-S and P-H diagrams and its analysis using T-S and P-h diagrams and Refrigeration Tables for sub cooled, saturated and superheated refrigerant, volumetric efficiency of compressor; Effect on performance of VCRS due to change in evaporator pressure, condenser pressure, sub cooling of liquid refrigerant, super heating of suction vapours; Actual vapour compression refrigeration cycle on T-sand P-h diagrams (no mathematical analysis); Numerical problems. Compound compression with single evaporator, Multi evaporators with single compressor, along with schematic representation of these systems with use of flash chamber, water intercooler, flash intercooler, with individual and multiple expansion valves arrangements. (Without numerical problems). (8)

4. Vapour Absorption Refrigeration Cycle

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 ;Electrolux refrigeration system; comparison between vapour absorption and compression systems (no mathematical analysis). (3)

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; Antifreeze solution; Leak detection and charging of refrigerants; Environmental aspects of conventional refrigerants; Ecofriendly refrigerants and action plan to reduce ecological hazards. (2)

6. Alternative Refrigeration Systems and Low Temperature Refrigeration

Steam Jet Refrigeration; Vortex Tube Refrigeration, Thermoelectric cooling; Cascade Refrigeration System; Simple Linde system and dual pressure Linde system for liquefaction of air, Claude system for liquefaction of air, cryogenics and its engineering applications (no mathematical analysis). (3)

7. Air Conditioning Concepts and Applications

Dry Air; Moist Air; Basic laws obeyed by Dry Air and Moist Air; Psychometric 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; Psychometric chart and its use; Numerical problems. Human requirement of comforts; effective temperature and comfort charts; Industrial and comfort air conditioning. (4)

8. Psychometric Processes

Basic psychometric processes; Adiabatic mixing of two air streams Sensible heating; Sensible cooling; cooling with dehumidification; cooling with humidification; Heating with dehumidification; Heating with humidification; By-pass factor; Contact factor; Sensible heat factor; Room sensible heat factor; Grand sensible heat factor. (4)

9. Air conditioning Load Calculations

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. (4)

10. Refrigeration and Air Conditioning Equipment

Description of refrigeration and air conditioning equipment, compressors, condensers, evaporators, air washer and expansion devices. (2)

Suggested Books:

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

BTME-804 Mechanical Vibrations

Internal Marks:	**40**	**L**	**T**	**P**
External Marks:	**60**	**3**	**1**	**0**
Total Marks:	**100**			

Course Objective: The course has the objective to understand the behavior of mechanical systems subjected to vibratory response. The basics of vibration and the influence of the damping, mass and stiffness on free and forced vibratory system for a single, two, multi and continuous degree of system is the main objective of this course. The students are expected to analyze the generalized vibratory system after the end of the course.

1. Introduction

Basic concepts, types of vibration, periodic and harmonic vibrations, methods of vibration analysis. (4)

2. Vibration of Single Degree of Freedom System

Undamped free vibration, damped free vibration and damped force vibration system, modeling of stiffness and damping (both viscous and coulomb), estimation of damping by decay plots, vibration isolation transmissibility, vibration measuring instruments. (11)

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 and 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. (10)

4. Multi-Degree of Freedom Systems

Undamped free vibrations, influence coefficients, generalized coordinates, orthogonality principal, matrix iteration method, Rayleigh and Dunkerley, Holzer's , Stodola method, eigen values and eigen vectors. (7)

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. (5)

Suggested Books:

12. Rao S S, Mechanical Vibrations, Pearson Education, Delhi
13. Thomson, Mechanical Vibration, Prentice Hall
14. G.K. Grover, Mechanical Vibrations, Hem Chand and Bros
15. K.K. Pujara, Mechanical Vibrations, Dhanpat Rai and Sons, Delhi
16. V.P.Singh, Mechanical Vibrations Dhanpat Rai and Sons, Delhi

BTME-805 Heat Transfer Lab

		L	T	P
Internal Marks:	**30**			
External Marks:	**20**	**0**	**0**	**2**
Marks:	**50**			

1. To determine thermal conductivity of an insulating powder material.
2. To determine thermal conductivity of a metal bar.
3. To determine thermal conductivity of a liquid.
4. To plot the temperature profile and to determine effectiveness and efficiency for a finite long fin.
5. To determine heat transfer coefficient under free convection at outer surface of a vertical tube.
6. To determine heat transfer coefficient under forced convection at inner surface of a pipe.
7. To determine overall heat transfer coefficient and effectiveness of parallel and counter flow heat exchangers.
8. To plot pool boiling curve for water and to determine its critical heat flux.
9. To determine emissivity of a test plate.
10. To study the performance of a heat pipe.

BTME-806 Refrigeration and Air Conditioning Lab

		L	T	P
Internal Marks:	**30**	**0**	**0**	**2**
External Marks:	**20**			
Total Marks:	**50**			

1. Study of various elements of a vapour compression refrigeration system through cut section model /refrigeration trainer.
2. Study and performance testing of domestic refrigerator.
3. Study and 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.

BTME-807 Mechanical Vibration Lab

Internal Marks:	**30**	**L**	**T**	**P**
External Marks:	**20**	**0**	**0**	**2**
Total Marks:	**50**			

1. Determination of radius of gyration of a pendulum.
2. Determination of radius of gyration of a bar using Bi-Filar suspension.
3. Determine the natural frequencies of a coupled pendulum.
4. Find out the fundamental natural frequency of a cantilever beam.
5. Determine the modulus of elasticity from free vibration test.
6. Study of forced vibration of a two degree of freedom system under harmonic excitation.
7. Study of a dynamic absorber.
8. Determine the coefficient of dry friction from measurement of natural frequency of vibration of a bar resting on two disks rotating in opposite direction.

Note: In addition to the above, simulations using MATLAB/SCILAB/scientific computational software may be performed for the experiments 4 to 8.

BTME-931 Non-Traditional Machining

Internal Marks: 40	**L T P**
External Marks: 60	**3 0 0**
Total Marks : 100	

Course Objective: The objective of this course is to provide students with an overview of various nontraditional machining processes and the concept of hybrid machining. The students will learn principles, equipment, process parameters, operations, capabilities and applications of nontraditional machining processes. Upon completion of the course, the students should have the ability to understand the importance of the nontraditional machining processes and their industrial application.

1. Introduction
Latest trends in manufacturing, introduction to flexible manufacturing system, limitations of conventional machining processes, development of nontraditional machining processes, their classification, advantages and major applications. (6)

2. Advanced Mechanical Processes
Ultrasonic machining (USM), abrasive jet machining (AJM), water jet machining (WJM) and abrasive water jet machining (AWJM) working principles, equipment, process parameters applications and limitations. (8)

3. Electrochemical & Chemical Removal Processes
Principle of operation, equipment used, process parameters applications and limitations of electrochemical machining, electrochemical grinding, electrochemical deburring, electrochemical honing, chemical machining. (8)

4. Thermal Metal Removal Processes
Electric discharge machining (EDM); mechanism of metal removal, electrode feed control, dielectric fluids and flushing, electrode material, applications and limitations, Plasma arc machining (PAM); Mechanism of metal removal, parameters, Equipment's used, safety precautions applications and limitations, Laser beam machining (LBM); principles, equipment, process parameters, limitations and applications, Electron beam machining (EBM); generation and control of electron beam, process capabilities, applications and limitations. (10)

5. Hybrid Machining Processes
Concept of hybrid machining, classification, application, Advantages and limitations. (4)

Suggested 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

BTME- 932 Power Plant Engineering

Internal Marks	**: 40**	**L**	**T**	**P**
External Marks	**: 60**	**3**	**1**	**0**
Total Marks	**: 100**			

Course Objectives: The course is formulated to understand different types of electric power generating plants, schematics and general description of each.

1. Introduction
Energy sources for generation of electric power, Principle and types of power plants, special features and applications, present status and future trends. (3)

2. Hydro Power Plant
Classifications, hydroelectric survey, rainfall run-off, hydrograph, flow duration curve, mass curve, storage capacity, Site selection, schematic and general description of hydro power plant. (5)

3. Steam Power Plant
General introduction, schematic and general description, developing trends, essential features, site selection, Coal storage, preparation, handling, feeding and combustion systems, ash handling, dust collection, high pressure boilers. (7)

4. Diesel and Gas Turbine Power Plants
General introduction, schematic and general description, Comparison with stream power plants, Operation of combined steam and gas power plants. (4)

5. Nuclear Power Plant
General introduction, nuclear fuels, nuclear energy, schematic and general description, types of nuclear reactors and applications, radiation shielding, radioactive waste disposal, safety aspects. (6)

6. Non-Conventional Power Plants
General introduction, schematic and general description of solar power plants bio-gas power plant, wind power plant, geothermal power plant and tidal power plant. (6)

7. 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. (5)

Suggested 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

BTME-933 Non-Destructive Testing

	L	T	P
Internal Marks: 40			
External Marks: 60	**3**	**0**	**0**
Total Marks: 100			

Course Objective: The course is so designed to understand the basic concepts of nondestructive testing. The students will have exposure to radiographic examinations, magnaflux method, electrical ultrasonic method and photoelasticity. After the study of this course, a student will be able to apply these concepts for non-destructive testing on materials.

1. Introduction

Classification of techniques of material testing, need and significance of nondestructive testing methods, type of nondestructive testing methods. (10)

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. (8)

3. Magnaflux Method

Basic principles, scope and applications, magnetic analysis of steel bars and tubing magnetization methods, equipment, inspection medium, preparation of surfaces fluorescent penetration inspection, demagnetization. (5)

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)

5. Photoelasticity

Concept and applications of plane and circular polarization, photo stress. (4)

Suggested Books:

1. Non-destructive Testing Techniques Ravi Prakash New Age Science
2. Practical Non-destructive Testing Baldev Raj, T. Jayakumar, M. Thavasimuthu, Narosa publishing house
3. H.E. Davies, G.E Troxell and GFW Hauck, The testing of Engg materials, Mc Graw Hill
4. W.H Armstrong, Mechanical Inspection, Mc Graw Hill

BTME-934 Industrial Tribology

	L	T	P
Internal Marks: 40			
External Marks: 60	**3**	**0**	**0**
Total Marks: 100			

Course Objective: The course is designed to understand the basic concepts of Tribology and its application on tribo-system. After the study of this course, a student is expected to have knowledge of tribological parameter and its influence on tribo element.

1. Introduction

Tribological considerations, Nature of surfaces and their contact, Physio-chemical properties of surface layer, Geometrical properties of surfaces, methods of studying surfaces, study of contact of smooth and rough surfaces. (10)

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. (12)

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. (8)

4. Special Topics

Selection of bearing and lubricant, bearing maintenance, diagnostic maintenance of tribological components, lubrication systems, filters and filtration. (6)

Suggested Books:

1. Standard Hand Book of Lubrication Engg., O'Conner and Royle, McGraw Hills Co
2. Introduction to Tribology, Halling , Wykeham Publications Ltd.
3. Lubrication, Raymono O. Gunther; Bailey Bros &Swinfan Ltd.
4. Rearing Systems, Principles and Practice, PT Barwll
5. Basic Lubrication Theory, A Cameron (Indian Edition)
6. Tribology Hand Book, Michel Ncole

BTME-935 Mechatronics

	L	T	P
Internal Marks: 40			
External Marks: 60	**3**	**0**	**0**
Total Marks: 100			

Course Objective: The course is designed to understand the basic concepts of mechatronics; sensors and transducers need for mechatronics; signal conditioning; pneumatic, hydraulic and electrical systems; applications for microprocessor and a microcontroller based project to grasp the concept of mechatronics.

1. Introduction to Mechatronics
Definition and approach of mechatronics, measurement and control systems, microprocessor based controllers. (5)

2. Sensors and Transducers
Performance terminology, displacement, velocity, position, proximity, force, fluid pressure, liquid level, temperature, and light sensors and transducers, procedure for selection. (6)

3. Signal Conditioning
Op Amp, Protection, digital signals, Multiplexes and digital signal processing, pulse modulation. (5)

4. Pneumatic and Hydraulic Systems
Actuation systems, Directions, pressure and process control valve, Pneumatic and hydraulic systems. (5)

5. Electrical Actuation System
Mechanical switches, solid state switches, solenoid, dc/ac motors, stepper motors. (5)

6. Programmable Logic Controllers
Basic structure and hardware components of PLCs, Ladder diagram and programming, Applications of PLCs for control of different systems. (6)

7. Microcontroller Based Project
Assemble a suitable system using Arduino microcontroller kit based on Uno system. (6)

Suggested Books:

1. W. Bolton, Mechatronics, Pearson Education.
2. Alciatore and Histand, Introduction to Mechatronics and Measurement Systems, Tata McGraw Hill
3. Ramachandran, Vijayaraghavan and Balasundaram, Mechatronics, Wiley - India.
4. www.arduino.cc

BTME-936 Modeling and Simulation

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

L T P
3 0 0

Course Objective: The goal is to introduce students to basic simulation methods and tools for modeling and simulation of continuous, discrete and combined systems. The course also helps to handle production and operations management systems, simulation software's etc**.**

1. Modeling

Need for system modeling, systems approach to modeling, open and feedback systems, combination of simple feedback systems, feedback time lag effects, feedback and managerial systems (4)

2. Production and Operations Management

Principles of analytical modeling, kinds of analytical methods, measures of effectiveness, cost analysis of large systems (6)

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, Introduction to simulation languages like SIMULA, SIMSCRIPT, GPSS etc. Statistical output analysis. (15)

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. (15)

Suggested 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.

BTME-937 Maintenance and Reliability Engineering

	L	T	P
Internal Marks: 40	**3**	**0**	**0**
External Marks: 60			
Total Marks: 100			

Course Objectives: The course is formulated to understand the maintenance system with breakdown estimation for planning the maintenance activities with the aim of total productive maintenance of the equipment and facilities of an organization. Reliability and failure analysis of system with estimation of breakdown for its improved availability is also key objective of this course.

1. Introduction
Objective and characteristics of maintenance function, organization of the maintenance system, operating practices in maintenance, maintenance record keeping. (3)

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)

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, Housekeeping practices, total productive maintenance. (5)

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)

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. (5)

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. (5)

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. (5)

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. (5)

Suggested 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.

BTME-938 Machine Tool Design

	L	T	P
Internal Marks: 40			
External Marks: 60	**3**	**0**	**0**
Total Marks: 100			

Course Objective: This course is designed to provide students with an overview of general requirements to machine tools design and machine tool drives. The students will learn the concepts of kinematics of machine tools and its design. Upon completion of the course, the students should have the ability to understand aspects of machine tool design and will be able to apply the knowledge gained for the practical applications.

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. (5)

2. Kinematics of Machine Tools
Kinematics or gearing diagram of Lathe, drilling Machine, Milling Machine etc. Main, drive and feed drive, specifications of Machine tools. (5)

3. Design of Kinematics Scheme
Methods to determine transmission ratios for drives, Development of kinematics scheme. (5)

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)

5. Design of Spindle and Spindle Bearings
Main requirements, Materials and details of spindle design, Spindle bearings, types of bearings and their selections. (4)

6. Columns, Tables and Ways
Materials, typical constructions and design. (4)

7. Machine Tools Control Systems
Requirement of control system, selection and construction of control systems, mechanical control system, remote control safety devices. (5)

8. Machine Tool Dynamics
Dynamic performance, dynamic and elastic system of Machine, tools. Dynamics of cutting forces, tool chatter. (5)

Suggested Books:

1. Sen and Bhattacharya, Machine Tools Design, CBS Publishers.

2. N.K. Mehta, Machine Tool Design, Tata McGraw Hill.
3. N. Acherkan, Machine Tool Design, Four Volumes, Mir Publishers.
4. S.K. Basu and D.K. Pal, Design of machine tools, Oxford and IBH.