B. Tech 3rd Sem Mechanical Engineering **Contact Hours: 22**

Course Code	Course Title	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTME-18301	Theory of Machines-I	3	1	0	40	60	100	4
BTME-18302	Thermodynamics	3	1	0	40	60	100	4
BTME-18303	Strength of Materials-I	3	1	0	40	60	100	4
BTME-18304	Materials Engineering	3	0	0	40	60	100	3
BTME-18305	Manufacturing Processes-I	3	0	0	40	60	100	3
BTME-18306	Strength of Materials Lab	0	0	2	30	20	50	1
BTME-18307	Manufacturing Process Lab	0	0	2	30	20	50	1
BTME-18308	Summer internship institutional training*				60	40	100	1
MEMC-I#	Constitution of India	0	0	0	-	-		0
		15	**03**	**04**	**320**	**380**	**700**	**21**

***The marks will be awarded on the basis of 04 weeks Institutional Practical Training conducted after 2nd Semester.**
 # Students will give presentations on the subject

B. Tech 4th Semester Mechanical Engineering **Contact Hours: 23**

Course Code	Course Title	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTME-18401	Theory of Machines-II	3	1	0	40	60	100	4
BTME-18402	Applied Thermodynamics	3	1	0	40	60	100	4
BTME-18403	Strength of Materials-II	3	1	0	40	60	100	4
BTME-18404	Fluid Mechanics	3	1	0	40	60	100	4
BTME-18405	Manufacturing Processes-II	3	0	0	40	60	100	3
BTME-18406	Applied Thermodynamics Lab	0	0	2	30	20	50	1
BTME-18407	Theory of Machines Lab	0	0	2	30	20	50	1
MEMC-II#	Environmental Science	-	-	-	-	-	-	0
		15	**04**	**4**	**260**	**340**	**600**	**21**

#Students will give presentations on the subject

B. Tech 5th Sem Mechanical Engineering **Contact Hours: 24**

Course Code	Course Title	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTME-18501	Heat Transfer	3	1	0	40	60	100	4
BTME-18502	Design of Machine Elements	3	0	2	40	60	100	4
BTME-18503	Mechatronics	3	1	0	40	60	100	4
BTME-18504	Fluid Machinery	3	1	0	40	60	100	4
BTXX-18XXX	Open Elective-I (Humanities)	3	0	0	40	60	100	3
BTME-18505	Heat Transfer Lab	0	0	2	30	20	50	1
BTME-18506	Fluid Mechanics & Machinery Lab	0	0	2	30	20	50	1
BTME-18507	Project-I (Summer internship)*	-	-	-	60	40	100	1
MEMC – III#	Essence of Indian Traditional Knowledge	-	-	-	-	-	-	-
		15	**03**	**06**	**320**	**380**	**700**	**22**

***The marks will be awarded on the basis of 06 weeks Industrial / Institutional l Training conducted after 4th Semester**
#Students will give presentations on the subject

B. Tech 6th Sem Mechanical Engineering **Contact Hours: 22**

Course Code	Course Title	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTME-18601	Statistical and Numerical Methods in Engineering	3	1	0	40	60	100	4
BTME-18602	Metrology, Measurement and Control	3	0	0	40	60	100	3
BTME-18XXX	Departmental Elective-I	3	0	0	40	60	100	3
BTME-18XXX	Departmental Elective-II	3	0	0	40	60	100	3
BTXX-18XXX	Open Elective-II (Humanities)	3	0	0	40	60	100	3
BTME-18604	Project-II (One mini project based on Mechatronics and one Design Project on high end software)*	0	0	6	30	20	50	3
		15	**01**	**06**	**230**	**320**	**550**	**19**

***The part design, assembly and drawing project will be given as per scope of Design of Machine Elements**

B. Tech 7th Sem Mechanical Engineering **Contact Hours: 24**

Course Code	Course Title	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTME-18701	Automation in Manufacturing	3	0	0	40	60	100	3
BTME-18702	Mechanical Vibrations	3	1	0	40	60	100	4
BTME-18XXX	Departmental Elective III	3	0	0	40	60	100	3
BTME-18XXX	Departmental Elective-IV	3	0	0	40	60	100	3
BTXX-18XXX	Open Elective-III	3	0	0	40	60	100	3
BTME-18703	Automation in Manufacturing Lab	0	0	2	30	20	50	1
BTME-18704	Project-III (Minor Project)	0	0	6	50	50	100	3
BTME-18705	Summer internship*	-	-	-	60	40	100	1
		15	**01**	**08**	**340**	**410**	**750**	**21**

***The marks will be awarded on the basis of 06 weeks Industrial / Institutional l Training conducted after 6th Semester**

B. Tech 8th Sem Mechanical Engineering **Contact Hours: 23**

Course Code	Course Title	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
BTME-18801	Refrigeration and Air Conditioning	3	1	0	40	60	100	4
BTME-18XXX	Departmental Elective V	3	0	0	40	60	100	3
BTME-18XXX	Departmental Elective VI	3	0	0	40	60	100	3
BTXX-18XXX	Open Elective-IV	3	0	0	40	60	100	3
BTME-18802	Refrigeration and Air Conditioning Lab	0	0	2	30	20	50	1
BTME-18803	Project-IV (Major Project)	0	0	08	100	50	150	4
		12	**01**	**10**	**290**	**310**	**600**	**18**

List of Departmental Electives

I. Design and Automation	II. Industrial Engineering
BTME-18920 Computer Aided Design & Manufacturing BTME-18921 Finite Element Analysis BTME-18922 Microprocessor in Automation	BTME-18925 Industrial Engineering and Management BTME-18926 Operation Research BTME-18927 Process Planning & Cost Estimation
III. Energy and Environment	**IV. Thermal Engineering**
BTME-18930 Renewable Energy Resources BTME-18931 Energy Conservation and Management BTME-18932 Environmental Science	BTME-18935 Power Plant Engineering BTME-18936 Internal Combustion Engines BTME-18937 Gas dynamics and Jet Propulsion
V. Materials and Manufacturing	**VI. Automobile Engineering**
BTME-18940 Non-Traditional Machining BTME-18941 Composite Materials BTME-18942 Jig Fixture and Die Design	BTME-18945 Automobile Engineering BTME-18946 Design of Transmission System BTME-18947 Alternate Fuels and Energy Systems

List of Open Electives

Open Electives – III	Open Electives – IV
BTME-18961 Industrial Safety and Environment BTME-18962 Total Quality Management BTME-18963 Reliability and Quality Control BTME-18964 Mechatronics	BTME-18965 Entrepreneurship BTME-18966 Materials Management BTME-18967 Management Information System BTME-18968 Computer Integrated Manufacturing

Third Semester
Mechanical Engineering

BTME-18301 Theory of Machines-I

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

Course Objectives: The course 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.

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 Corliolis Components). **(6)**

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. **(6)**

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. **(5)**

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. **(3)**

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. **(8)**

Course Outcomes:

1. Explain the working of various primitive components of a machine.
2. Develop mathematical skills for the computation of industry related problems.
3. Determine various physical parameters of power transmission devices, friction devices and different governing devices.
4. Compute the essential parameters like fluctuation of speed and energy in a flywheel of a vehicle etc.

Suggested Readings / Books:

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

BTME-18302 Thermodynamics

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

Course Objectives: The course has been designed to cover heat interactions and balance of energy between system and its surroundings, to learn about application of first and second law to various thermodynamic systems, to learn about gas power cycles and IC engines, to learn about steam formation and its properties, to learn about vapor power cycles.

1. Basic Concepts

Definition of thermodynamics, concept of temperature and heat, microscopic and macroscopic approach, concept of continuum, thermodynamic systems, thermodynamic equilibrium, property, state, path, process and cycle, reversible and irreversible processes, types of work transfer, sign convention for heat and work interaction, Zeroth law of thermodynamics. **(4)**

2. First Law of Thermodynamics

Concept of first law of thermodynamics, internal energy and enthalpy, work transfer in non-flow process, application of first law for different processes (isobaric, isochoric, isothermal, adiabatic and polytropic) and cycle in non-flow (closed) system, free expansion process, work transfer in flow process, application of first law for different processes (isobaric, isochoric, isothermal, adiabatic and polytropic) in flow (open) system, steady flow energy equation and its application for various thermodynamic systems, throttling process and its applications. **(8)**

3. Second Law of Thermodynamics

Limitations of first law of thermodynamics, concept and statements (their equivalence) of second law of thermodynamics, thermodynamic temperature scale, Carnot engine and Carnot theorem, Carnot refrigerator and heat pump, Clausius theorem and concept of entropy, principle of increase in entropy, representation on T-S coordinates and change in entropy of different processes, concept of entropy generation in closed and open systems, high grade and low grade energy, available and unavailable energy, second law efficiency and exergy analysis of thermodynamic systems, third law of thermodynamics (definition only). **(8)**

4. Gas Power Cycles and I.C. Engines

Nomenclature of piston-cylinder arrangement w.r.t. swept volume, clearance volume, compression ratio and mean effective pressure; Analysis and comparison of air standard cycles i.e. Otto Cycle, Diesel cycle and dual cycle; Classification of I.C. engines, construction and application two stroke and four stroke petrol and diesel engines, combustion phenomenon of C.I. and S.I. engines, knocking and detonation, supercharging and turbocharging of I.C. engines, performance of IC engines w.r.t. indicated power, brake power, mechanical efficiency and thermal efficiency. **(8)**

5. Steam Formation and Vapor Power Cycles

Classification of steam generators (boilers), mountings and accessories of boilers, equivalent evaporation and efficiency of boilers, modern high pressure and super critical boilers; Pure substance, steam formation at constant pressure and properties of steam, use of steam tables and Mollier chart; Carnot vapor power cycle and its limitations, Rankine vapor power cycle (ideal and actual), effect of pressure and temperature on Rankine cycle efficiency, methods to improve Rankine cycle efficiency i.e. reheating, regeneration and bleeding, Introduction to binary vapor cycle and combined gas-vapor cycle. **(8)**

Course Outcomes:

1. Apply energy balance to systems and control volumes in situations involving heat and work interactions.
2. Evaluate changes in thermodynamic properties of substances.
3. Evaluate performance of energy conversion devices.
4. Explain and apply various gas power and vapor power cycles.

Suggested Books:

1. Sonntag R. E, Borgnakke C. and Van Wylen G. J., Fundamentals of Thermodynamics, Wiley India Pvt. Ltd.
2. Jones, J. B. and Duggan R. E., Engineering Thermodynamics, Prentice-Hall of India.
3. Moran M. J. and Shapiro H. N., Fundamentals of Engineering Thermodynamics, John Wiley and Sons.
4. Nag P.K., Engineering Thermodynamics, Tata McGraw-Hill Publishing Co. Ltd.
5. Mahesh Rathore, Thermal Engineering, McGraw-Hill Education (India) Pvt. Ltd.
6. R. Yadav, Sanjay and Rajay, Applied Thermodynamics, Central Publishing House.

BTME-18303 Strength of Materials-I

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

Course Objectives:

The course has been design to help students to understand the nature of stresses developed in simple geometries such as bars, cantilevers, beams, and shafts for various types of simple loads. Students should be able to calculate the elastic deformation occurring in various simple geometries for different types of loading.

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. **(8)**

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 **(7)**

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 aforementioned 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. **(7)**

Course Outcomes:

1. Analyze the nature of internal stresses that will develop within the components under various types load applied.
2. Evaluate the strains and deformation that will result due to the elastic stresses developed within the materials for simple types of loading.
3. Evaluate stresses and strains under pure shear or combined shear and bending stress.
4. Design columns and struts under various loading conditions.
5. Explain and evaluate slope and deflection of various types of beams under different loading conditions.

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.

BTME-18304 Materials Engineering

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

Course Objectives: Understanding of the correlation between the internal structure of materials, their mechanical properties and various methods to quantify their mechanical integrity and failure criteria. To provide a detailed interpretation of equilibrium phase diagrams and learning about different phases and heat treatment methods to tailor the properties of Fe-C alloys.

1. **Crystal Structure**: Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress. **(8)**

2. **Mechanical Property measurement**: Tensile, compression and torsion tests; Young's modulus, relations between true and engineering stress-strain curves, generalized Hooke's law, yielding and yield strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell and Vickers and their relation to strength. **(8)**

3. **Static failure theories:** Ductile and brittle failure mechanisms, Fracture mechanics: Introduction to Stress intensity factor approach and Griffith criterion. Fatigue failure: High cycle fatigue, Stress-life approach, SN curve, endurance and fatigue limits, effects of mean stress using the Modified Goodman diagram; Fracture with fatigue, Introduction to non-destructive testing (NDT). **(8)**

4. **Alloys, substitutional and interstitial solid solutions- Phase diagrams**: Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotectic reactions. Iron Iron-carbide phase diagram and microstrctural aspects of ledeburite, austenite, ferrite and cementite, cast iron. **(8)**

5. **Heat treatment of Steel:** Annealing, tempering, normalising and spheroidising, isothermal transformation diagrams for Fe-C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening **(8)**

Course Outcomes:

1. Identify crystal structures for various materials and understand the defects in such structures.
2. Recognize techniques to tailor material properties of ferrous alloys
3. Quantify mechanical integrity and failure in materials

4. Explain various components of phase diagrams and microstructure development

Suggested Books:

1. W. D. Callister, 2006, "Materials Science and Engineering-An Introduction", 6th Edition, Wiley India.
2. Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 4th Indian Reprint, 2002.
3. V. Raghavan, "Material Science and Engineering', Prentice Hall of India Private Limited, 1999.

BTME-18305 Manufacturing Processes-I

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

Course Objectives: 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. Introduction to additive manufacturing and rapid prototyping. (6)

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. (12)

3. Welding Processes

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

(14)

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. (8)

Course Outcomes:

1. Classify the various manufacturing processes.
2. Describe principles of casting processes and their elements; patterns, sand moulds, gating system and cores etc.
3. Recognize metal melting process and special casting processes.
4. Define the principle and classification of various welding processes.
5. Identify the casting and welding defects and their causes and remedies.
6. Select a suitable process to fabricate the required engineering component.

Suggested Readings / Books:

1. 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.

BTME-18306 Strength of Material lab

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

L T P
0 0 2

List of Experiments

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.

Course Outcomes:

1. Analyze deformation of ductile and brittle material under tensile and compressive loads.
2. Evaluate hardness of engineering materials using appropriate scale.
3. Determine mechanical properties of materials.
4. Determination of Bucking loads for columns and struts under various loading conditions.

BTME-18307 Manufacturing Process Lab

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

Course Objectives: This course is designed to help students to have practical knowledge of various Manufacturing Processes. They will understand the importance of process variables controlling these processes. Upon completion of the course, the students should have the ability to select types of manufacturing processes needed for the manufacturing of various geometrical shapes of products.

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.

Course Outcomes:

1. Recognize various Manufacturing Processes.
2. Apply the drawings/ sketches for a manufacturing process.
3. Recognize the importance of machining parameters and impact of the parameters on the machining process.
4. Determine the type of the manufacturing process needed for the manufacturing of various geometrical shapes of products.

BTME-18308 Summer Internship Institutional Training

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

Fourth Semester
Mechanical Engineering

BTME-18401 Theory of Machines-II

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

Course Objectives: 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. **(5)**

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. **(6)**

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. **(6)**

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. **(5)**

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)**

Course Outcomes:

1. Compute forces and couples on various machine elements.
2. Implement balancing of various dynamic parts like rotating and reciprocating masses as in case of V- engines etc.
3. Assess gyro effect in two- wheelers and four- wheelers.
4. Select the gear arrangement for a power transmission system.

Suggested Readings / Books:

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

BTME-18402 Applied Thermodynamics

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

Course Objectives: To learn construction, working, application and analysis of various thermodynamic systems like nozzles, steam turbines, condensers, compressors, gas turbines and jet propulsion.

1. Nozzles, Steam Turbines and Condensers

Definition and types of nozzles, condition for maximum discharge through nozzle, significance of critical pressure ratio, supersaturated flow through nozzle. Classification of steam turbines, compounding of steam turbines, velocity diagram, performance analysis and comparison of impulse and reaction turbines, losses in steam turbines, reheat factor, governing of steam turbines. Function, classification and performance analysis of condensers. **(8)**

2. Thermodynamics of Compressors

Classification, working and application of different types of compressors, representation of compression process on P-V and T-S coordinates, applications of steady flow energy equation; static and stagnation parameters for flow through dynamic compressors, ideal and polytropic work required for compression process; isothermal, isentropic and polytropic efficiency, heat carried away by cooling medium. **(5)**

3. Positive Displacement Air Compressors

Construction and working detail of reciprocating compressors, performance analysis of reciprocating compressors, free air delivery, volumetric, overall volumetric, isothermal, isentropic and polytropic efficiency, effect of various parameters on volumetric efficiency, performance characteristics of reciprocating compressors; Construction and working detail of rotary (roots blower, vane compressor and screw compressor) positive displacement compressors, comparison of reciprocating compressors and rotary positive displacement compressors, work input and efficiency of rotary compressors, performance characteristics. **(7)**

4. Dynamic Compressors

Construction, working, applications and performance analysis of centrifugal compressors, pre-whirl, slip factor, power input factor and pressure coefficient of centrifugal compressors, energy transfer in radial, forward and backward vanes, losses in centrifugal compressors, characteristic curves, surging and choking. Construction, working, applications and performance analysis of axial flow compressors, theory of aerofoil blading, lift and drag coefficients, degree of Reaction and its derivation, surging, choking and stalling, comparison of centrifugal and axial flow compressor, characteristic curves. **(8)**

5. Gas Turbines and Jet Propulsion

Construction, working, classification and applications of gas turbines, comparison of gas turbines with steam turbines and IC engines, performance analysis of constant pressure gas turbine cycle (Brayton cycle), thermal refinements like regeneration, inter-cooling and re-heating, selection criteria for gas turbine blade materials, gas turbine fuels, cooling of turbine blades. Construction, working, classification, applications and analysis of jet propulsion systems (turbojet, turbo prop, ran jet and pulse jet), construction, working, applications and analysis of rocket engines. **(8)**

Course Outcomes:

1. Design nozzles, steam turbines and condensers in thermal power plants.
2. Define and design different type of compressors
3. Describe and design gas turbines and jet propulsion systems.

Suggested Books:

1. Sonntag R. E, Borgnakke C. and Van Wylen G. J., Fundamentals of Thermodynamics, Wiley India Pvt. Ltd.
2. Jones, J. B. and Duggan R. E., Engineering Thermodynamics, Prentice-Hall of India.
3. Moran M. J. and Shapiro H. N., Fundamentals of Engineering Thermodynamics, John Wiley and Sons.
4. Nag P.K., Engineering Thermodynamics, Tata McGraw-Hill Publishing Co. Ltd.
5. Mahesh Rathore, Thermal Engineering, McGraw-Hill Education (India) Pvt. Ltd.
6. R. Yadav, Sanjay and Rajay, Applied Thermodynamics, Central Publishing House.

BTME-18403 Strength of Materials-II

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

Course Objectives:
The course is designed to help undergraduate students 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.

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. **(5)**

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 springsderivation of formula for strain energy, maximum stress and rotation. Leaf spring deflection and bending stresses. **(5)**

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. **(4)**

8. Rotational Discs

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

Course Outcomes:

1. Explain various types of strain energy and analyze strain energy in different systems.
2. Formulate different mathematical equations for various theories of failure and apply under different conditions.
3. Design thin and thick cylinders under various conditions.
4. Understand the concept of shear stress and analyze shear stress for different cross section of beams.
5. Analyze different types of stresses involved in rotating components, springs and curved beams.

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.

BTME-18404 Fluid Mechanics

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

Course Objectives: 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. Introduction: 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; 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. (5)

3. Fluid Kinematics: Classification of fluid flows; Path line, streak line, streamline and timelines; Flow rate and discharge mean velocity; 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. (6)

4. Fluid Dynamics: Derivation of Euler's equation of motion in Cartesian coordinates, 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. (6)

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. (6)

6. Internal Flows Laminar and Turbulent Flows: Reynolds number, critical velocity, critical Reynolds number; Hagen-Poiseuille equation; Darcy equation; Head losses in pipes and pipe fittings. (7)

7. Boundary layer theory: Concept of boundary layer, characteristics of boundary layer, analysis of boundary layer on a flat plate, Concept & analysis of boundary layer thickness, displacement thickness, momentum thickness, energy thickness. (5)

8. Potential flow: Concept of potential flow, definition of source & sink, sink flow, free vortex flow, concept of Ranking body or plane half body. (3)

Course Outcomes:

- Explain behaviour of fluids at rest or in motion and the subsequent effects of the fluids on the boundaries.
- Interpret various types of fluid flow.
- Categorize properties of various types of fluids.
- Solve different types of problems related to fluid flow in pipes, design the experiments effectively.
- Analyze concepts related to fluid measurement.

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. Y.A. Cengel and J.M. Cimbala, Fluid Mechanics - Fundamentals and Applications, Tata McGraw Hill.
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. V.L. Streeter, E.B. Wylie and K.W. Bedford, Fluid Mechanics, Tata McGraw Hill.

BTME-18405 Manufacturing Processes-II

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

Course Objectives: 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. Introduction to 3D printing. **(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)**

Course Outcomes:

1. Understand different types of the machine tools and their processes.
2. Compute various forces associated with the cutting tools.
3. Characterize different materials used in cutting processes and understand impact of the coolant during cutting.
4. Understand the principle and classification of various metal forming processes and determine the load coming during the processes.
5. Comprehend powder metallurgy process.

Suggested Readings / 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. S. Kalpakjian and S. R. Schmid, Manufacturing EngG. and Tech., 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-18406 Applied Thermodynamics Lab

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

L T P
0 0 2

1. To study of construction and operation of 2-stroke and 4-stroke petrol and diesel engines using actual engines or models.

2. To study construction and working of various types of boilers.

3. To 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.

4. To study construction, working and operation of a multi-stage reciprocating air compressor.

5. Performance testing of 4-stroke, multi-cylinder petrol engine in terms of brake power, indicated power, mechanical efficiency, specific fuel consumption and heat balance sheet. (Morse Test).

6. Performance testing of 4-stroke, single cylinder diesel engine in terms of brake power, indicated power, mechanical efficiency, specific fuel consumption and heat balance sheet.

Course Outcomes:

1. Determine dryness fraction of steam and estimation of brake power.
2. Compute Rankine efficiency, relative efficiency, generator efficiency and overall efficiency of an impulse steam turbine.
3. Perform testing of 4-stroke, multi-cylinder petrol engine.
4. Perform testing of 4-stroke, single cylinder diesel engine

BTME-18407 Theory of Machines Lab

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

Course Objectives: The students will have the practical understanding the basic concepts of mechanisms and will be able to understand the concept of displacement, velocity and acceleration in the mechanism. They will also gain knowledge of working of governors, gyroscope, cams, gears, bearing belt drive and flywheel.

List of experiments

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

Course Outcomes:

1. Determine the displacement, velocity and acceleration of machine elements.
2. Compute various physical parameters of governors, cams, flywheel and gyroscope.
3. Conduct the balancing of dynamic rotating masses.
4. Determine the gear-train value of compound gear trains and epicyclic gear trains.

Fifth Semester
Mechanical Engineering

BTME-18501 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. Lumped system approximation and Biot number. (10)

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 convection, Derivation of three dimensional mass, momentum and energy conservation equations, 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 convection, Heat transfer in laminar and turbulent flow over a plate, Heat transfer in laminar and turbulent flow through a tube, Types of heat exchangers, Overall heat transfer coefficient, Log mean temperature difference for parallel and 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 criteria for heat exchangers. (10)

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 Boltzmann's law, Intensity of Radiation, Emissivity, absorptivity, reflectivity and transmissivity, Concept of black and gray bodies, Plank's law of monochromatic radiation, Kirchhoff'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. (8)

Course Outcomes:

1. Mathematically analyze conduction, convection, radiation, pool boiling and condensation processes of heat transfer.
2. Analyze the reducing/enhancing rate of heat transfer in various industrial processes/systems.
3. Explain the properties of various materials/surfaces related to the process of heat transfer.
4. Analyze heat transfer equations for designing various systems involving heat transfer.
5. Use various modelling and simulation tools for solving heat transfer problems.

Suggested Books:

1. A. Bejan, Heat Transfer John Wiley, 1993.
2. J.P.Holman, Heat Transfer, Eighth Edition, McGraw Hill, 1997.
3. Frank P. Incropera and David P. Dewitt, Fundamentals of Heat and Mass transfer, John Wiley, 2007.
4. MassoudKaviany, Principles of Heat Transfer, John Wiley, 2002.
5. Yunus A. Cengel, Heat Transfer: A Practical Approach, McGraw Hill, 2002.
6. A.J. Chapman, Heat Transfer, McGraw Hill Book Company, New York.
7. Eckert & Drake, Heat and Mass Transfer, McGraw Hill Book Company, New York.
8. Mahesh M. Rathore, Engineering Heat and Mass Transfer, Laxmi Publications (P) Ltd.
9. D.S. Kumar, Heat & Mass Transfer, S K Kataria & Sons.
10. R.K.Rajput. Heat and Mass Transfer, S. Chand & Company Ltd.

BTME-18502 Design of Machine Elements

Internal Marks: 40 **L T P**
External Marks: 60 **3 0 2**
Total Marks: 100

Course Objectives: This course is intended to understand mechanical design, design process, design ethics, design considerations, fracture mechanics, 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, couplings, pipe joints, various elements of transmission drive, which includes frictional drive, chain drive, gear drive, bearings, brakes and clutches and springs are understood in this course. After the study, students are expected to design the suitable joint for a desired load; and design a shaft, and coupling for a specified power transmission.

1. Basic Design Considerations
Meaning of mechanical design, conceptual design, design process, design tools, general design considerations, Material selection, economic considerations, manufacturing considerations, safety and product liability, stress and strength, factor of safety, reliability, limits, fits and standardization concept of tearing, bearing, shearing, crushing, bending and fracture, stress concentration, contact stresses. (6)

2. Failure Theories in Design
Static strength, failure theories for ductile and brittle materials, Introduction to fracture mechanics. 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. (6)

3. Design of Joints
Riveted joints, threaded fasteners, pre-loaded bolts and welded joints, design of pipe joints with oval flange, square flange, design of spigot and socket cotter joint, gib and cotter joint, knuckle joint. (4)

4. Design of Shafts and Couplings
Shafts under static and fatigue loadings, Analysis and applications of power screws and couplings. (4)

5. Design of Springs
Helical compression, tension, torsional and leaf springs. (4)

6. Design of Transmission Elements
Belt, rope and chain drives, spur, helical, bevel and worm gears. (5)

7. Design of Bearing

Slider Bearing, Principle of hydrodynamic lubrication, modes of lubrication, Reynolds equation, bearing performance parameters, slider bearing design. Roller Bearing, Types, selection guidelines, static and dynamic load carrying capacity, Steinbeck's equation, equivalent bearing load, load life relationship, selection of bearing, comparison of roller and slider bearing. (6)

8. Design of clutches and brakes

Design of contact clutches i.e. plate, multi-disc, cone and centrifugal clutches. Design of band, disc, block with shoe and internal expanding brakes. (5)

Course Outcomes:

1. Recognize the scope of design of machine elements, design process.
2. Analyze impact of load on machine elements and failure behavior of machine elements.
3. Formulate and design various joints, transmission derives, brakes, clutch, spring and bearings.
4. Integrate the technical and scientific knowledge to select and design suitable machine elements.

Suggested Books:

1. Bhandari, V.B. Design of Machine elements, Tata McGraw Hill
2. Shigley, J.E. and Mischke, C.R., Mechanical Engineering Design, Fifth Edition, McGraw-Hill International; 1989.
3. Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan, 1992.
4. Juvinal, R.C., Fundamentals of Machine Component Design, John Wiley, 1994.
5. Spottes, M.F., Design of Machine elements, Prentice-Hall India, 1994.
6. R. L. Norton, Mechanical Design – An Integrated Approach, Prentice Hall, 1998

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-18503 Mechatronics

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

Course Objective: This course provides student opportunity to learn about various sensors, pneumatic & hydraulic systems and microcontrollers. Using this they will be able to build automated solutions.

1. Introduction to Mechatronics

Definition and approach of Mechatronics, Mechatronic systems, Measurement and Control Systems, Microprocessor based controllers and Mechatronics Approach. (5)

2. Sensors and Transducers

Position Sensors: Limit switch, photoelectric switches, proximity sensors, pneumatic limit valves and backpressure sensors, pressure switches, resolvers, incremental & absolute encoders, decoders & relays. Displacement Sensors: Potentiometer sensors, LVDT, capacitive displacement sensors. Velocity sensors: Tachogenerator, use of encoders. (6)

3. Signal Conditioning

Signal conditioning process, Operational amplifier (inverting amplifier, non-inverting amplifier, summing, integrating amplifier), filtering, data acquisition, multiplexer, analog to digital converter (ADC), digital to analog converter (DAC). Oscillators to generator sinusoidal, square, triangular and impulse waveform. (6)

4. Pneumatic and Hydraulic Systems

Actuation systems, Directions, pressure and flow control valve, Pneumatic and hydraulic systems. (4)

5. Microcontroller

Comparison between microprocessor and micro controller, organization of a microcontroller system, architecture of MCS 51 controller, pin diagram of 8051, addressing modes, instruction types and set, Application. (5)

6. Programmable Logic Controllers (PLC)

Introduction, PLC system and components of PLC, input output module, PLC advantages and disadvantages. Ladder diagram & PLC programming fundamentals: Basic components and other symbols, fundamentals of ladder diagram, machine control terminology, update-sole ladder-update, physical components Vs. program components, light control example, internal relays, disagreement circuit, majority circuit, oscillator, holding (sealed or latches) contacts, always ON always OFF contacts, Nesting of ladders. (6)

7. Mechatronics Systems

Traditional Vs Mechatronic Design, Case studies of Mechatronic systems designs, like piece counting system, pick and place manipulator, Part loading / unloading system, automatic tool and pallet changers etc. (3)

Course Outcomes:

1. Select and use appropriate Transducers & Sensors for automated solutions.
2. Compare different actuating and controlling systems for automation.
3. Program and implement solutions using various Microcontrollers.
4. Program and automated solutions using PLC.

Suggested Books:

1. Mechatronics – W. Bolton, Pearson education
2. Mechatronics – Mahalik, TATA McGraw Hill
3. Microprocessor 8085 – Gaokar
4. Mechatronics – Appu Kuttam, Oxford publications
5. Automated Manufacturing systems, S. Brain Morris, McGRaw Hill

BTME-18504 Fluid Machinery

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 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)

4. Centrifugal Pumps Layout and Installation

Main elements and their functions; Various types and classification; Pressure changes in a pump-suction, delivery and manometric heads; vane shape and its effect on head-capacity relationships; 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)

5. Similarity Relations and Performance Characteristics

Unit quantities, specific speed and model relationships, scale effect; cavitation; Concept of Net Positive Suction Head (NPSH) and its application in determining turbine/ pump setting. (5)

6. Reciprocating Pumps

Components parts and working; pressure variations due to piston acceleration; acceleration effects in suction and delivery pipes; work done against friction; maximum permissible vacuum during suction stroke; Air vessels. (5)

7. 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)

Course Outcomes:

1. Formulate the engineering problems using various formulae about working of turbo machine.
2. Analyze the fluid flow in different types of turbines.
3. Evaluate the working of different pumps.
4. Apply the analytical tools to solve different types of problems related to various hydraulic devices & systems.

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-18505 Heat Transfer Lab

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

Course Objective: This course provides student opportunity to learn the concept of various modes of heat transfer i.e. conduction, convection and radiation.

List of Experiments

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 of a finite long fin.
5. To determine heat transfer coefficient at outer surface of a vertical tube under free convection.
6. To determine heat transfer coefficient at inner surface of a pipe under forced convection.
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.

Course Outcomes:

1. Demonstrate theoretical knowledge of heat transfer for conducting the experiments.
2. Analyze the experimental heat transfer data for presenting in useful form.
3. Explain practical aspect of basic fundamentals of heat transfer.
4. Explain effect of various parameters on performance of heat transfer/thermal systems.

BTME-18506 Fluid Mechanics & Machinery Lab

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

Course Objective: This course provides student opportunity to understand the behaviour of fluids at rest or in motion and the subsequent effects of the fluids on the boundaries and analyze practical problems of various types of hydraulic turbines and pumps under working conditions.

List of Experiments

1. To verify Bernoulli's energy equation for flow through a variable area duct.
2. To determine the coefficient of discharge for an obstruction flow meter (venturimeter/orifice meter).
3. To ascertain the lower critical Reynolds number for transition of flow from laminar to turbulent.
4. To determine the friction coefficients for pipes of different diameters.
5. To calculate efficiency of Francis Turbine.
6. To calculate efficiency of reciprocating pump and to perform test on it for determination of pump performance.
7. To draw characteristic curves for a Pelton Turbine.
8. To perform test on Centrifugal pump for determination of its performance.

Course Outcomes:

1. Analyze fluid flow through different paths.
2. Calculate efficiency for different types of turbines.
3. Analysis the working of different pumps analytically.
4. Apply the analytical tools to solve different types of problems related to different hydraulic devices & systems.

Sixth Semester
Mechanical Engineering

BTME-18601 Statistical and Numerical Methods in Engineering

Internal Marks: 40 **L T P**
External Marks: 60 **3 1 0**
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 operators, 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-Maclaurin 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)

8. 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–Seidel 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.

Course Outcomes:

1. Formulate the engineering problems using statistical techniques, probability and sampling distributions.
2. Analyze the significance difference in fit from mean and variance of the measured data.
3. Solution of algebraic/transcendental equation; linear system of equations, ordinary and partial differential equations related with mechanical engineering.
4. Interpolate the data on the basis of its trend and to estimate the differential and integration of integrand.

Suggested Books:

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

BTME-18602 Metrology Measurement and Control

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

Course Objectives: 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.

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)

Course Outcomes:

1. Explain the importance of measurement, metrology and control in the industry.
2. Estimate errors and uncertainty in measurements using statistical analysis.
3. Recognize working principles in the measurement of field quantities.
4. Identify sensors and transducers for different measurements.

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 Measurement systems, McGraw Hill, 1998

Seventh Semester
Mechanical Engineering

BTME-18701 Automation in Manufacturing

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

Course Objective: The course is designed to understand various elements of manufacturing automation – CAD/CAM, sensors, pneumatics, hydraulics and CNC and the role of manufacturing automation.

1. Introduction

Concept and scope of automation: Socio economic impacts of automation, Types of Automation, Current trends, CAD, CAM, CIM, Rigid automation: Part handling, Machine tools. Flexible automation. (3)

2. Low Cost Automation

Hydraulic and pneumatic cylinders - construction, design and mounting; Hydraulic and pneumatic valves for pressure, flow and direction control. Direct and Indirect Control of single/double acting cylinders, Design of logic circuits for a given time displacement diagram & sequence of operations, Hydraulic & pneumatic circuits using control valves, Speed Control of a cylinder. (7)

3. Computer Aided Design

Fundamentals of CAD - Hardware in CAD-Computer Graphics Software and Data Base, Need and types of Geometric Modeling: Wireframe, surface and solid modeling; Solid Modeling Techniques: Boundary Representation (B-rep), Constructive Solid Geometry (CSG). (6)

4. Computer Aided Manufacturing

CNC machine tools: basic components, coordinate systems, Tooling for CNC machines, tool length compensation, tool radius compensation; Direct Numerical Control, Adaptive control in machining system. Manual part programming for CNC lathe and milling machines. Basics of Programmable logic controllers (PLC), Architecture and components of PLC, Ladder logic diagram. (12)

5. Computer Integrated Manufacturing

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, Automated Material handling. Assembly. (5)

Course Outcomes:

1. Design pneumatic/hydraulic circuits to implement low cost automation.
2. Analyze different geometric modeling techniques.
3. Apply computer based automation.

4. Explain NC machine tools, CAD-CAM-CNC integration for various mechanical engineering applications.
5. Explain Computer integrated manufacturing and Flexible Manufacturing Systems and future trends.
6. Write part programs for milling, drilling and turning cycles for NC machines to manufacture complex parts.

Suggested Books:

1. Mikell P. Groover, Automation, Production Systems, and Computer-integrated Manufacturing, PHI
2. D.D. Bedworth, M.R Henderson & P.M. Wolfe, Computer Integrated Design and Manufacturing, Tata McGraw Hill
3. Yoram Koren, Computer control of manufacturing system, 1st edition
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
7. SeropeKalpakjian and Steven R. Schmid, Manufacturing – Engineering and Technology,Pearson

BTME-18702 Mechanical Vibrations

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

Course Objectives: The course is designed to understand the sources of vibration and make design modifications to reduce the vibration and improve the life of the components.

1. Introduction

Basic concepts, Types of vibration, Periodic & Harmonic vibrations, Methods of vibration analysis using Fourier series and partial differential equations. (3)

2. Vibration of Single Degree of Freedom System

Un-damped free vibrations, damped free vibrations and damped force vibration system, Modelling of stiffness and damping (both viscous and coulomb), estimation of damping by decay plots, vibration isolation transmissibility, vibration measuring instruments. (10)

3. Two Degrees of Freedom Systems

Principal modes of vibrations, natural frequencies, amplitude ratio, un-damped free, damped free, forced harmonic vibration, semi-definite systems, combined rectilinear & angular modes; Lagrange's equation. Application to un-damped and damped absorbers: Vibration absorber-principle; centrifugal pendulum vibration absorber, torsional vibration damper, un-tuned dry friction and viscous vibration damper, torsional vibration absorber. (12)

4. Multi Degree of Freedom Systems

Un-damped free vibrations, influence coefficients, Generalised coordinates, orthogonality principal, matrix iteration method, Rayleigh and Dunkerley, Holzer's, Stodola method, Eigen values and Eigen vectors. (10)

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)

Course Outcomes:

1. Determine the natural frequency of single of freedom system (damped or un-damped).
2. Analyze the mathematical modeling of the two degrees of freedom systems and explain about the working principle of vibration absorber.
3. Compute the natural frequencies and mode shapes of a multi degree of freedom system and explain the modal analysis of a vibrating system.
4. Develop design parameters and indicate methods of solution for a complicated vibratory problem.

Suggested Books:

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

BTME-18703 Automation in Manufacturing Lab

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

Course Objective: This course provides student opportunity to learn advanced manufacturing methods and form dimensional accuracy of products.

List of Experiments

1. Design of hydraulic / pneumatic circuit for automatic reciprocating movement of double acting cylinder using appropriate direction control valves.
2. Design of hydraulic / pneumatic circuit for clamping by using appropriate direction control valve and pressure control valves.
3. Programming of a PLC using ladder diagram.
4. Measurement of cutting forces in Milling/ Turning process
5. Write manual part program for machining given part on a CNC lathe.
6. Write manual part program for machining given part on a CNC milling machine.
7. Use of Tool Maker's Microscope
8. Measurement of an angle with the help of sine bar
9. Measurement of surface roughness of a machined Plate, Rod and Pipe
10. Bore diameter measurement using micrometer and telescopic gauge
11. Use of Autocollimator
12. Use of stroboscope for measurement of speed of shaft

Course Outcomes:

1. Design hydraulic / pneumatic circuit for automation.
2. Measure cutting forces for proper selection of tools.
3. Measure surface finish of machined parts.
4. Program and automated solutions using PLC.
5. Measure dimensions within tolerance limits.

Eighth Semester
Mechanical Engineering

BTME-18801 Refrigeration and Air-Conditioning

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

Course Objectives:
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
Classification of refrigeration systems, 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. (4)

2. Vapour Compression Refrigeration Cycles
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)

3. 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; Eco-friendly refrigerants and action plan to reduce ecological hazards. (5)

4. Vapour Compression Refrigeration System Components
Compressors, Condensers, Expansion devices and Evaporators-Performance matching of components of refrigeration systems (Condensing unit and compressor-capillary tube). (5)

5. 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). (4)

6. Psychrometry

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. (5)

7. 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. (5)

8. 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)

Course Outcomes:

1. Explain and evaluate the performance of vapour compression refrigeration system.
2. Analyze the vapour absorption refrigeration system.
3. Explain the concept of psychrometry and its application in air conditioning systems.
4. Explain the performance matching of components of refrigeration systems.

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

BTME-18802 Refrigeration and Air Conditioning Lab

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

Course Objectives:

To introduce the students for hand on practice to perform the experiment and evaluate the experimental record pertaining to refrigeration cycles of various refrigeration systems. To impart the students with training of interfacing the theoretical and practical skills. Refrigeration and Air Conditioning and its primary components such as evaporators, condensers, capillary tubes, expansion valve etc.

List of Experiments

1. Demonstration of various elements of a vapour compression refrigeration system through refrigeration trainer.
2. Performance testing of domestic refrigerator using refrigeration test rig.
3. Performance testing of Electrolux refrigerator.
4. Study of an Ice plant.
5. Calculation/ Estimation of cooling load for a large building.
6. Visit to a central air conditioning plant for the of study air-conditioning system.
7. Visit to a cold storage for study of its working.
8. Performance testing of window type room air conditioner.
9. Performance testing of water cooler.

Course Outcomes:

1. Conduct and analyze the experimental data of performance of vapour compression refrigeration system in domestic refrigerator and water cooler.
2. Conduct and analyze the experimental data of performance of Electrolux Refrigerator.
3. Conduct the performance of window type room air conditioner and system.
4. Analyze the industrial set up for the working and use of vapour compression refrigeration system in cold storage.

Department Elective-I
(Design and Automation)

BTME 18920 Computer Aided Design and Manufacturing

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 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

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. (5)

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. (6)

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. (7)

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

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)

Course Outcomes:

1. Explain computer graphics systems and analyze different geometric modeling techniques.
2. Formulate mathematical equations for generation and transformation of curves and surfaces in CAD environment
3. Explain NC machine tools, CAD-CAM-CNC integration for various mechanical engineering applications.
4. Explain Computer integrated manufacturing and Flexible Manufacturing Systems and future trends.
5. Write part programs for milling, drilling and turning cycles for NC machines to manufacture complex parts.

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-18921 Finite Element Analysis

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

Course Objectives: To illustrate the principle of mathematical modeling of engineering problems and introduce the basics and applications of Finite Element Methods to solve engineering problems.

1. Introduction

Historical Background, Mathematical modeling of field problems in engineering, governing equations, discrete and continuous models, boundary and initial value problems, Weighted Residual Methods, Variational formulation of boundary value problems, Ritz technique, Basic concept of Finite Element Method. (7)

2. One Dimensional Problems

One dimensional second order equation, discretization, linear and higher order elements, derivation of shape functions, Stiffness matrix and force vectors, assembly of elemental matrices, solution of problems from solid mechanics and heat transfer, longitudinal vibration and mode shapes, fourth order beam equation, transverse deflections and natural frequencies. (7)

3. Two Dimensional Problems

Two dimensional equations, variational formulation, finite element formulation, triangular elements- shape functions, elemental matrices and RHS vectors; application to thermal problems, torsion of non-circular shafts, quadrilateral and higher order elements. Plane stresses and plane strain problems, body forces and thermal loads, plate and shell elements. (12)

4. Numerical Integration

Natural coordinate systems, isoparametric elements and shape functions, numerical integration and application to plane stress problems, matrix solution techniques, solution of dynamic problems, introduction to FE software. (6)

Course Outcomes:

1. Apply finite element methods to tackle engineering problems.
2. Analyze one and two dimensional engineering problems.
3. Discretization and assembly of elemental matrices.
4. Solve dynamic problems using finite element method.

Suggested Books:

1. Reddy J.N., An Introduction to Finite Element Method, Tata McGraw Hill.
2. Seshu P., Text Book of Finite Element Analysis, Prentice Hall, New Delhi.
3. Rao S.S., The Finite Element Method in Engineering, Butterworth Heinemann, 2004.
4. Chandraputla & Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall.

BTME-18922 Microprocessor in Automation

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

Course Objectives: To introduce the basic concepts of Digital circuits, Microprocessor system and digital controller.

1. Introduction

Number Systems, codes, digital electronics: Logic Gates, combinational circuits design, Flip-flops, Sequential logic circuits design: Counters, Shift registers. Introduction to 8085 Functional Block Diagram, Registers, ALU, Bus systems, Timing and control signals. Machine cycles, instruction cycle and timing states, instruction timing diagrams, Memory interfacing. (7)

2. Assembly Language Programming

Addressing modes, Instruction set, simple programs in 8085; Concept of Interrupt, Need for Interrupts, Interrupt structure, Multiple Interrupt requests and their handling, Programmable interrupt controller. (7)

3. Interfacing peripherals

Programmable peripheral interface (8255). Interfacing Analog to Digital Converter & Digital to Analog converter, Multiplexed seven segments LED display systems, Stepper Motor Control, Data Communication: Serial Data communication (8251), Programmable Timers (8253); 8086/8088 Microprocessor and its advanced features. (10)

4. Introduction to Digital Control

Sampling theorem, Signal conversion and Processing, Z-Transform, Digital Filters, Implementation of Digital Algorithm. (6)

Course Outcomes:

1. Program using assembly language.
2. Apply digital filters and implement digital algorithms.
3. Interface peripheral systems for data communication.
4. Design logic circuits using block diagrams and logic gates.

Suggested Books:

1. Digital Electronics: An Introduction to Theory and Practice, William H. Gothmann, PHI Learning Private Limited.
2. Digital Computer Electronics: An Introduction to Microcomputers, Albert Paul Malvino, Tata McGraw-Hill Publishing Company Ltd.
3. Microprocessor Architecture, Programming, and Applications with the 8085, Ramesh Gaonkar, PENRAM International Publishers.
4. Digital Control Systems, Benjamin C. Kuo, Oxford University.
5. Microcomputer Experimentation with the Intel SDK-85, Lance A. Leventhal, Prentice Hall.

Department Elective-II
(Industrial Engineering)

BTME-18925 Industrial Engineering & Management

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

Course Objectives: The course is designed to understand 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 etc.

1. Introduction
Definition and scope of industrial engineering, Functions of industrial engineering department and its organization, Qualities of an industrial engineer, concept of production and productivity. (3)

2. Concept of Management
Functions of Management, Evolution of Management Thought: Taylor's Scientific Management, Fayol's Principles of Management, Douglas Mc-Gregor's Theory X and Theory Y, Mayo's Hawthorne Experiments, Hertzberg's Two Factor Theory of Motivation, Maslow's Hierarchy of Human Needs – Systems Approach to Management. (6)

3. Designing Organizational Structures
Concept, Importance and characteristics of organization, Types of organization - Project, matrix and informal organization. Span of control, Delegation of authority. (4)

4. Management Planning, Decision Making and Control
Steps, hierarchy, principles and dimensions of planning function, Approaches to decision making, Decision support systems, Basic control process, control parameters, principles of control. (5)

5. Plant Location and Layout
Plant location: definition, factors affecting the plant location, comparison of rural and urban sites-methods for selection. Plant layout: Needs for a good layout, Different types viz. Product, process and combination layouts, Introduction to layouts based on the GT, JIT and cellular manufacturing systems, Development of plant layout. (6)

6. Productivity
Definition, reasons for low productivity, methods to improve productivity, relation between work-study and productivity. (2)

7. Work Analysis
Definition, need and scope of Work Analysis. Method-study: Definition, objectives, step-by-step procedure, questioning techniques, charts and diagrams for recording data. Principles of motion economy; Development and installation of new method. Work–measurement: Definition, various

techniques of work-measurement such as work-sampling, stopwatch time study & its procedure, Job selection, Equipment and Forms used for work measurement, need for rating operator, methods of rating, allowances and their types, standard time. Standard data techniques. (8)

8. Value Engineering

Definition, Types of values, concept, phases and application of value engineering. (2)

Course Outcomes:

1. Identify and formulate industrial engineering problems.
2. Recognize different plant locations and layouts for engineering industry.
3. Analyse and interpret data for setting the standard methods and standard time by applying industrial engineering techniques.
4. Apply the concept of value analysis for reducing the product cost and cycle time.

Suggested Books:

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

BTME-18926 Operations Research

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

Course Objectives: The course is designed to understand the 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. (4)

4. Simulation

Concept general approach and application. Use of Monte-Carlo simulation technique to queuing and inventory problems. (3)

5. Dynamic Programming

Introduction to deterministic and probabilistic dynamic programming. Solution of simple problems. (3)

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

Inventory models: Classification of inventory control models: Inventory models with deterministic demand, inventory models with probabilistic demand, 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)

Course Outcomes:

1. Explain various mathematical deterministic operation research models.
2. Describe the problems of probabilistic and simulation models.
3. Demonstrate the queuing, inventory and replacement models etc.
4. Formulate and analyze the network models.

Suggested Books:

1. Principles of Operations Research HM Wagner, Prentice Hall.
2. Operations Research PK Gupta and DS Hira, S. Chand & Co.
3. Introduction to Operation Research Taha
4. Introduction to Operation Research F.S. Hiller and G.I. Libermann, Holden Ray.

BTME-18927 Process Planning and Cost Estimation

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

Course Objectives: The course is designed to introduce the process planning concepts to make cost estimation for various products after process planning

1. Introduction to Process Planning
Introduction of Process Planning- methods of process planning, drawing interpretation, material evaluation, steps in process selection, production equipment and tooling selection. (6)

2. Process Planning Activities
Process parameters calculation for various production processes, selection of jigs and fixtures, selection of quality assurance methods, documents for process planning, economics of process planning, case studies. (8)

3. Introduction to Cost Estimation
Importance of costing and estimation, methods of costing, elements of cost estimation, types of estimates, estimating procedure, estimation of labour cost, material cost, allocation of overhead charges, calculation of depreciation cost. (8)

4. Machining Time Estimation
Importance of machine time calculation, machining time for different lathe operations, drilling and boring time calculations, Machining time calculation for Milling, Shaping, Planning and Grinding. (7)

5. Production Costs
Different production processes for different jobs, estimation of forging cost, estimation of welding cost, estimation of foundry cost, and estimation of machining cost. (7)

Course Outcomes:

1. Implement the selection process for equipment and tools for industrial systems.
2. Evaluate process planning activities and quality assurance.
3. Demonstrate the product cost estimation techniques for direct and indirect cost.
4. Analyze the machining time for various machining operations.

Suggested Books:

1. Peter scalon, “Process planning, Design/Manufacture Interface”, Elsevier science technology Books, Dec 2002.
2. Sinha B.P, “Mechanical Estimating and Costing”, Tata-McGraw Hill publishing co, 1995.
3. Ostwaal P.F. and Munez J., Manufacturing Processes and Systems, 9th ed., John Wiley 1998.
4. Chitale A.V. and Gupta R.C., Product Design and Manufacturing, 2nd ed., Prentice Hall 2002.

Department Elective-III
(Energy and Environment)

BTME-18930 Renewable 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. (6)

Course Outcomes:

1. Describe energy scenario in India and abroad.
2. Explain conventional and non-conventional energy resources.
3. Explain the basic theory and systems for harnessing different renewable energy resources.
4. Explain various direct energy conversion systems.

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-18931 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. (4)

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. (12)

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)

Course Outcomes:

1. Describe energy scenario in India and abroad.
2. Explain conventional and non-conventional energy resources and impact of their use on environment.
3. Describe various energy conservation policies of Govt. of India.
4. Explain the methodology for energy conservation and management in various utilities.
5. Describe the procedure for carrying out energy audit of any industry/organization.

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.

BTME-18932 Environmental Science

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

Course Objective: This course is designed to understand for creating the awareness about environmental problems among people, imparting basic knowledge about the environment and its allied problems, developing an attitude of concern for the environment, motivating public to participate in environment protection and environment improvement, acquiring skills to help the concerned individuals in identifying and solving environmental problems and striving to attain harmony with Nature.

1. Introduction

Definition and scope and importance of multidisciplinary nature of environment. Need for public awareness. (2)

2. Natural Resources

Introduction and types of natural Resources and associated problems, use and over exploitation of resources. (4)

3. Ecosystem and Biodiversity

Concept and types of Ecosystem, Structure and functions of ecosystem, producers, consumers and decomposers, ecological pyramids, Introduction to biodiversity, levels of biodiversity, values of biodiversity, importance (uses) of biodiversity, Hot spots of biodiversity, Threats to biodiversity, Conservation of biodiversity (in situ and ex situ techniques). (6)

4. Environmental Pollution

Introduction, definition, sources, effects and control measures of Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution. Nuclear hazards. Solid waste Management: Types, sources, causes and effects of solid wastes, Methods of solid waste disposal. (6)

5. Disaster Management

Introduction, characteristics and types of Disasters, Causes, effects and control measures of Floods, earthquake, cyclone and landslides. (3)

6. Global Environment Issues

Concept of sustainable development, Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation, Climate change, Global warming (Greenhouse effect), Acid rain, Ozone layer depletion, Wasteland reclamation. (4)

7. Legislation for Environmental Protection

Air (Prevention and Control of Pollution) Act, Water (Prevention and Control of pollution) Act, Environment Protection Act, Wildlife Protection Act, Forest Conservation Act, their objectives and salient features. (3)

8. Environment and Human Population:

Population growth, Population explosion, Environment and human health, Human Rights, Value Education, Environmental ethics, Role of Information Technology in Environment and human health. (4)

Course Outcomes:

1. Measure environmental variables and interpret results.
2. Evaluate local, regional and global environmental topics related to resource use and management.
3. Propose solutions to environmental problems related to resource use and management.
4. Interpret the results of scientific studies of environmental problems.
5. Describe threats to global biodiversity, their implications and potential solutions.

Suggested Books:

1. Erach Bharucha, University Press.
2. Environmental Studies, MP Poonia & SC Sharma, Khanna Publishing House.
3. Environmental Studies, Rajagopalan, Oxford University Press.

Department Elective-IV
(Thermal Engineering)

BTME-18935 Power Plant Engineering

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

Course Objective: 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. (2)

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. (4)

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. (6)

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. (5)

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)

Course Outcomes:

1. Describe basic fundamentals of conduction, convection and radiation mode of heat transfer.
2. Explain various heat transfer equations.

3. Analyse heat transfer equations for designing various thermal systems.
4. Analyse heat transfer data for obtaining the logical conclusions.

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-18936 Internal Combustion Engines

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

Course Objective: The course is advanced level course of internal combustion 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)

Course Outcomes:

1. Explain fundamentals of IC engines.
2. Explain thermodynamic analysis of IC engines.
3. Analyze combustion characteristics of IC engines.
4. Analyze emission characteristics of IC engines.

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-18937 Gas Dynamics and Jet Propulsion

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

Course Objective: This course is designed to understand the features of compressible isentropic flows and irreversibilities like shocks and provide a basic knowledge of jet and rocket propulsion technologies.

1. Fundamentals of Compressible Flow

Continuity, Momentum and energy equation, Control volume, Sonic velocity, Mach number and its significance, Mach waves, Mach cone and Mach angle, Von Karman rules of supersonic flow, Static and stagnation states, Relationship between stagnation temperature, Pressure, Density and enthalpy in terms of Mach number, Stagnation velocity of sound, Reference speeds, Various regions of flow, Effect of Mach number on compressibility. (6)

2. Isentropic Flow with Variable Area

One dimensional isentropic flow in ducts of varying cross-section nozzles and diffusers, Mass flow rate in nozzles, Critical properties and choking, Area ratio as function of Mach number, Impulse function, Effect of back pressure variation of convergent and convergent divergent nozzles, Non-dimensional mass flow rate in terms of pressure ratio, Area ratio and Mach number, Flow through diffusers, operation and analysis of C-D- nozzles, Use of gas tables. (6)

3. Flow in Constant Area Duct with Friction (Fanno flow)

Fanno curve and Fanno flow equations, Solution of Fanno flow equations, Variation of flow properties, Variation of Mach no. with duct length, Frictional choking, Isothermal flow in constant area duct with friction, Tables and charts for Fanno flow. (4)

4. Flow in Constant Area Duct with Heat Transfer (Rayleigh Flow)

Rayleigh curve and Rayleigh flow equations, Variations of flow properties, Maximum heat transfer, Thermal Choking, Tables and charts for Rayleigh flow. (4)

5. Normal and Oblique Shock Waves

Development of shock wave, Governing equations, Prandtl-Mayer relation, Rankine-Hugoniot relation, Strength of shock wave, Mach number in the downstream of normal shock, Variation of flow parameters across the normal shock, Normal shock in Fanno and Rayleigh flows, Compression shock wave and expansion fan, Analysis of oblique shock wave. (5)

6. Jet Propulsion:

Construction, working, classification, applications and analysis of jet propulsion systems (turbojet, turbo prop, ran jet and pulse jet), construction, working, applications and analysis of rocket engines. (6)

Course Outcomes:

1. Solve flow equations for quasi one-dimensional flow through variable area ducts.
2. Analyze flow through constant area ducts with friction and heat transfer.
3. Analyze flows with normal and oblique shocks.
4. Analyze mass flow rate in terms of different variables.

Books and References:

1. Dynamics of Compressible Flow by S.M. Yahya, New Age Publishers.
2. Fundamentals of Compressible Fluid Dynamics by P. Balachandran, PHI Learning.
3. Fundamental of Gas Dynamics by V. Babu, CRC Press.
4. Gas Dynamics by E. Rathakrishanan, PHI Learning

Department Elective-V
(Materials and Manufacturing)

BTME-18940 Non-Traditional Machining

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

Course Objectives: 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.

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)

Course Outcomes:

1. Explain the importance of the nontraditional machining processes and their industrial applications
2. Demonstrate the constructional features of non-traditional machining processes.
3. Select the suitable non-traditional machining process for a particular product.
4. Explain mechanism of metal removal for various non-traditional machining processes.

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-18941 Composite Materials

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

Course Objectives: The course is designed to obtain knowledge on classification, processing, characterization and applications of composite materials and to get an overview of mechanical properties and failure mechanisms of composites under loading conditions for engineering applications.

1. Introduction

Introduction: Definition, history, characteristics, classifications, advantages and limitations, industrial scenario and applications. (2)

2. Material and Micro-structural Parameters

Material and micro-structural parameters of composites. Unidirectional-fibre composites: Fibre characteristics. Longitudinal strength and modulus of composites, minimum and critical fibre volume fractions, factors affecting strength. Transverse strength and modulus. (8)

3. Performance of Composites

Failure Modes: Single and multiple fractures. Short-fiber composites: Stress transfer, critical fiber length. Modulus and strength. Whiskers and whisker reinforced composites. (6)

4. Particulate composites

Large-particle composites and dispersion-strengthened composites. Cermets. Zirconia toughened ceramics. Interface: Interface characteristics and their effects on adhesive, frictional and mechanical bonding mechanisms. Coupling agents and their role on the properties composites. Interface coatings. (10)

5. Properties of Composites

Static mechanical properties, fatigue, impact and creep properties, fracture behaviour and damage tolerance. (10)

6. Advanced Composites

Nano-composites, hybrid composites, sandwich composites, in-situ composites, smart composites, self-healing composites, and carbon-carbon composites. (4)

Course Outcomes:

1. Recognize the classification, processing, characterization and applications of various composite materials.
2. Characterization of the composite material for industrial application.

3. Explain different deformation and failure mechanisms of composite materials under different loading conditions in engineering applications
4. Characterization of the properties of advanced composite materials.

Suggested books:

1. Composite Materials: Science and Engineering; Krishan K. Chawla, Springer, 2012
2. Gibson R.F. Principles of Composite Material Mechanics, second edition, McGraw Hill, 1994.
3. Hyer M.W., Stress Analysis of Fiber- Reinforced Composite Materials, McGraw Hill, 1998.

BTME-18942 Jigs Fixtures and Die Design

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

Course Objectives: The course is designed to understand the basic concepts of jigs, fixtures and press tool design.

1. Introduction

Definition; importance of process planning for jigs, fixtures and tool design; selection and sequence of operations, machines, tools/die sets, gauges etc.; process planning sheet; case study. (5)

2. Jigs & Fixtures

Definition; classification of jigs and fixtures; When a Jig or a Fixture is needed, Principles of economics of Jigs and Fixtures; design considerations for location, clamping and guiding devices; selection of Jigs / Fixtures. Design of Drill Jigs, Milling Fixtures, Lathe Fixtures, Assembly Fixtures, welding fixtures, Inspection fixtures, Broaching Fixtures; Hydraulic, Pneumatic and Magnetic devices for clamping; Actual design problems. (15)

3. Press Tool Design

Types of Presses and selection, Press accessories and attachments; Chutes, Magazines, Hoppers, Roll feeds, Dials. Automatic stops, hand feed and pin stops; Development of blanks and scrap strip layouts; Types of Die sets, Selection between Dies; Die materials; Design considerations for Dies, actual design problems of Blanking dies, Piercing dies, Combination dies, Progressive dies, Bending dies; Design considerations for Forming and Forging dies, Trimming dies. (15)

Course Outcomes:

1. Explain different tools and die designs for specific applications.
2. Implementation of location, clamping and guiding devices for jigs, fixtures and press tools.
3. Design of various jigs and fixtures.
4. Design parameters required for various types of dies

Suggested books:

1. Edward G. Hoffman, “Jig and fixture Design”, Delmer cengage learing
2. C. Elanchezhian, T. Sunder Selwyn, B. Vijaya Ramnath, “Design of *Jigs*, *Fixtures* and *Press Tools*”, Eswar Press
3. Joshi, “Jigs *and* Fixtures*”,* TataMcGraw -*Hill*
4. Fred Herbert Colvin, Lucian Levant Haas, “Jigs *and* Fixtures”, BiblioBazaar
5. Hiram E. Grant, “Jigs *and* Fixtures Non-standard Clamping Devices”, TataMcGraw –Hill

Department Elective-VI
(Automobile Engineering)

BTME-18945 Automobile Engineering

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

Course Objectives:
To broaden the understanding in the structure of vehicle chassis and body, Fuel supply system, Lubrication, Cooling, suspension, transmission, steering, braking and electric systems. To introduce students to terminologies used in automobiles, performance characterization of the engines and to identify the method to improve the performance of the engines and to develop the ability of the students to identify the cause and remedy of the problem in automobiles.

1. Introduction
Basic structure, general layout and type of automotive vehicles, Frameless and unitary construction; position of power unit. (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. (3)

3. Fuel Supply System
Air cleaner and fuel pumps; Air fuel requirements and carburation; Modifications in a simple carburettor to meet different starting, running, idling and accelerating conditions; constructional details of carburetors and fuel injection systems used in Indian make vehicles. Diesel fuel system - cleaning, injection pump, injector and nozzles. (6)

4. Lubrication and Cooling Systems
Necessity of lubrication; Desirable properties of lubricants; various types of lubricants and oil additives; different systems of lubrication - oil filters, oil pumps and oil pressure indicator; crank case ventilation and dilution. Purpose of cooling, air and water-cooling systems; radiator, thermostat, pump and fan. (5)

5. Chassis and Suspension
Loads on the frame, considerations of strength and stiffness, engine mounting, conventional and independent suspension systems; shock absorbs and stablizers; wheels and tyres. (3)

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

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. (3)

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. (2)

10. Maintenance

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

Course Outcomes:

1. Identify the basic structure and functioning of the automobiles.
2. Recognize and manage inventory related to automobile industry/set up.
3. Applying his knowledge in the subject and serve as service engineer.
4. Demonstrate safety, care and routine maintenance of the vehicles.

Suggested Books:

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

BTME-18946 Design of Transmission System

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

Course Objectives:

To gain knowledge on the principles and procedure for the design of Mechanical power Transmission components, standard procedure available for Design of Transmission of Mechanical elements and to use standard data and catalogues.

1. Design of Flexible Elements

Design of Flat belts and pulleys – Selection of V belts and pulleys – Selection of hoisting wire ropes and pulleys – Design of Transmission chains and Sprockets. (7)

2. Spur Gears and Parallel Axis Helical Gears

Speed ratios and number of Teeth-Force analysis -Tooth stresses – Dynamic effects – Fatigue strength – Factor of safety – Gear materials – Design of straight tooth spur & helical gears based on strength and wear considerations – Pressure angle in the normal and transverse plane-Equivalent number of teeth-forces for helical gears. (7)

3. Bevel, Worm and Cross Helical Gears

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demerits terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair. Cross-helical: Terminology-helix angles-Estimating the size of the pair of cross helical gears. (7)

4. Gear Boxes

Geometric progression – Standard step ratio – Ray diagram, kinematics layout -Design of sliding mesh gearbox – Design of multi speed gear box for machine tool applications – Constant mesh gear box – Speed reducer unit. – Variable speed gearbox, Fluid Couplings, Torque Converters for automotive applications. (7)

5. Cams, Clutches and Brakes

Cam Design: Types-pressure angle and under cutting base circle determination-forces and surface stresses. Design of plate clutches –axial clutches-cone clutches-internal expanding rim clutches- Electromagnetic clutches. Band and Block brakes – external shoe brakes – Internal expanding shoe brake. (7)

Course Outcomes:

1. Implement the concepts of design to belts, chains and rope drives.
2. Implement the concepts of design to spur, helical gears.
3. Implement the concepts of design to worm and bevel gears.

4. Implement the concepts of design to gear boxes.
5. Implement the concepts of design to cams, brakes and clutches

Suggested Books:

1. Bhandari V, Design of Machine Elements, Tata McGraw-Hill Book Co.
2. Joseph S., Charles M., Richard B. and Keith N. Mechanical Engineering Design, Tata McGraw-Hill.
3. Sundararajamoorthy T.V. Shanmugam. N, Machine Design, Anuradha Publications, Chennai.
4. Robert C. J. and Kurt M. M., Fundamentals of Machine Design, Wiley.
5. Bernard Hamrock, Steven Schmid,Bo Jacobson, Fundamentals of Machine Elements, Tata McGraw-Hill.

BTME-18947 Alternative Fuels and Energy Systems

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

Course Objectives: To present a depth knowledge of Alternate fuel and energy system and to address the underlying concepts and methods behind alternate fuel and energy system.

1. Introduction

Effects of constituents of Exhaust gas emission on environmental condition of earth (N_2, CO_2, CO, NOx, SO_2, O_2) Pollution created by Exhaust gas emission in atmosphere. Greenhouse effect, Factors affecting greenhouse effect. Emission norms as per Bharat Standard and procedures for confirmation on production. (6)

2. Hydrogen as Engine Fuel

Production methods of hydrogen. Combustive properties of hydrogen. Problems associated with hydrogen as fuel and solutions. Different methods of using hydrogen in SI and CI engines. Performance, emission and combustion analysis in engines. Hydrogen storage - safety aspects of hydrogen. (10)

3. Biogas, Natural Gas and LPG as Fuels

Production methods of Biogas, Natural gas and LPG. Properties studies. CO2 and H2S scrubbing in Biogas., Modification required to use in SI and CI Engines- Performance and emission characteristics of Biogas, NG and LPG in SI and CI engines. (10)

4. Electric, Hybrid and Fuel Cell Vehicles

Layout of Electric vehicle and Hybrid vehicles - Advantages and drawbacks of electric and hybrid vehicles. System components, Electronic control system - Different configurations of Hybrid vehicles. Power split device. High energy and power density batteries - Basics of Fuel cell vehicle. (10)

Course Outcomes:

1. Recognize the environment impact of the emission from the vehicles.
2. Identify the various alternative fuels available for the vehicles.
3. Compare the properties, performance characteristics and combustion characteristics of different fuels.
4. Choose different areas of alternate fuels and energy system.
5. Describe the applications of different alternatives in day-to-day life.

Suggested Books:

1. Richard L Bechtold P.E., Alternative Fuels Guide book, Society of Automotive Engineers.
2. Alternate Fuels by Dr. S. Thipse, Jaico Publications
3. Automotive Emission Control by Crouse, AND Anglin – McGraw Hill.
4. Alternative Fuels Guidebook by Bechtold R.

Open Elective-III

BTME-18961 Industrial Safety and Environment

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 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. (04)

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. (04)

3. Safety Measures

Safety Measures in a Manufacturing Organization, Safety and Economics, Safety and Productivity, Employees Participation in Safety. Safety Standards and Legislation. (04)

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. (08)

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. (08)

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. (08)

Course Outcomes:

1. Recognize the importance of industrial safety, risk management, and the role of the safety manager.
2. Characterize the various safety measures and how it leads to increasing plant productivity.
3. Explain the engineering, administrative, and personal protective equipment controls or other interventions to reduce or eliminate hazards.
4. Describe basics of environmental design, its importance and control the environmental factor.

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-18962 Total Quality Management

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 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 employee's 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)

Course Outcomes:

1. Implement the concept of TQM in industry.
2. Analyze the real industrial situation using elements and principles like JIT, TWE, QFD, TEI and benchmarking concept.
3. Use TQM techniques to solve quality related industrial problems.
4. Adopt quality system standards and advanced TQM techniques in industry.

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-18963 Reliability and Quality Control

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

Course Objectives: To introduce the concept of SQC, to understand process control and acceptance sampling procedure and their applications, to learn the concept of reliability.

1. Introduction
Definition of Quality, Quality function, Dimensions of Quality, Brief history of quality methodology, Statistical methods for quality improvement, Quality costs, Introduction to Quality function deployment. (4)

2. Quality Assurance
Introduction, Definition, Management principles in QA, Forms of QA, QA in different stages. Quality planning, QA program, QA aspect, Quality in material management, Vendor selection & development. (4)

3. Acceptance Sampling Statistical Process Control
Introduction to statistical process control, Concept of variation, Assignable & Chance causes, Attributes & variables, Frequency distribution curve & its types. Normal Distribution curve, Problems on FD curve & ND curve, Application of SPC. (4)

4. Control Charts for Variables
Definition, Formulae & its problems. Control chart patterns, Process capability. Problems on x & R chart and Process capability. (4)

5. Control Charts for Attributes
Definition, Formulae & its problems. Problems on p, c charts. Choice between variables and attributes control charts. Guidelines for implementing control charts. (4)

6. Sampling Inspection
Sampling: Definition, types of sampling, importance, benefits and limitations of sampling, Operating Characteristic Curve, Average Outgoing Quality Curve, Errors in Making Inferences from Control Charts (Type I and II errors). (4)

7. Reliability Concepts
Introduction of Reliability concepts, Failure data analysis and examples, Failure rate, Failure density, Probability of failure, Mortality rate, Mean time to failure, Reliability in terms of Hazard rate and Failure Density, examples, Useful life and wear out phase of a system. (6)

8. System Reliability and Improvement

Reliability of series and parallel connected systems and examples, Logic diagrams, Improvement of system reliability, Element Redundancy, Unit redundancy, Standby redundancy. (6)

Course Outcomes:

1. Implement the concept of quality assurance in industry.
2. Use SQC methods to have good control on the processes in manufacturing and service industry.
3. Use sampling techniques to solve quality related industrial problems.
4. Improve system reliability by removing the redundancies in quality system.

Suggested Books:

1. Grant E L, Statistical Quality Control“, McGraw-Hill.
2. Mahajan, “Quality Control and Reliability”, Dhanpat Rai & Sons
3. Srinath L S, “Reliability Engineering”, East west press.
4. Sharma S C, Inspection Quality Control and Reliability, Khanna Publishers

BTME-18964 Mechatronics

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

Course Objective: This course provides student opportunity to learn about various sensors, pneumatic & hydraulic systems and microcontrollers. Using this they will be able to build automated solutions.

1. Introduction to Mechatronics

Definition and approach of Mechatronics, Mechatronic systems, Measurement and Control Systems, Microprocessor based controllers and Mechatronics Approach. (5)

2. Sensors and Transducers

Position Sensors: Limit switch, photoelectric switches, proximity sensors, pneumatic limit valves and backpressure sensors, pressure switches, resolvers, incremental & absolute encoders, decoders & relays. Displacement Sensors: Potentiometer sensors, LVDT, capacitive displacement sensors. Velocity sensors: Tachogenerator, use of encoders. (6)

3. Signal Conditioning

Signal conditioning process, Operational amplifier (inverting amplifier, non-inverting amplifier, summing, integrating amplifier), filtering, data acquisition, multiplexer, analog to digital converter (ADC), digital to analog converter (DAC). Oscillators to generator sinusoidal, square, triangular and impulse waveform. (6)

4. Pneumatic and Hydraulic Systems

Actuation systems, Directions, pressure and flow control valve, Pneumatic and hydraulic systems. (4)

5. Microcontroller

Comparison between microprocessor and micro controller, organization of a microcontroller system, architecture of MCS 51 controller, pin diagram of 8051, addressing modes, instruction types and set, Application. (5)

6. Programmable Logic Controllers (PLC)

Introduction, PLC system and components of PLC, input output module, PLC advantages and disadvantages. Ladder diagram & PLC programming fundamentals: Basic components and other symbols, fundamentals of ladder diagram, machine control terminology, update – sole ladder – update, physical components Vs. program components, light control example, internal relays, disagreement circuit, majority circuit, oscillator, holding (sealed or latches) contacts, always ON always OFF contacts, Nesting of ladders. (6)

7. Mechatronics Systems

Traditional Vs Mechatronic Design, Case studies of Mechatronic systems designs, like piece counting system, pick and place manipulator, Part loading / unloading system, automatic tool and pallet changers etc. (3)

Course Outcomes:

1. Select and use appropriate Transducers & Sensors for automated solutions.
2. Compare different actuating and controlling systems for automation.
3. Program and implement solutions using various Microcontrollers.
4. Program and automated solutions using PLC.

Suggested Books:

1. Mechatronics – W. Bolton, Pearson education
2. Mechatronics – Mahalik, TATA McGraw Hill
3. Microprocessor 8085 – Gaokar
4. Mechatronics – Appu Kuttam, Oxford publications
5. Automated Manufacturing systems, S. Brain Morris, McGRaw Hill

Open Elective-IV

BTME-18965 Entrepreneurship

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

Course Objectives: The course is designed to understand the basic concepts of Entrepreneurial Motivation, Steps in Creativity Innovation and inventions, Organization Assistance from the Govt., Rules and Legislation.

1. Introduction

Entrepreneurship Development: Meaning, objectives, scope & philosophy, type of entrepreneurs, factors affecting entrepreneurship, entrepreneurial qualities, need for promotion of entrepreneurship & small business, linkage between entrepreneurship and economic development, problem of increasing unemployment, creativity & entrepreneurship, harnessing locally available resources. (4)

2. Production and Financial Management

Brief introduction to various types of product strategies, pricing strategies, channel strategies and promotional strategies. Sources of finance and working capital management. (6)

3. Creativity

Creativity and entrepreneurship; Steps in Creativity Innovation and inventions; Using left brain skills to harvest right brain ideas; Legal Protection of innovation; Skills of an entrepreneur; Decision making and Problem Solving;(steps indecision making). (6)

4. Small Enterprises and Enterprise Launching Formalities

Definition of Small Scale; Rationale; Objective; Scope; SSI; Registration; NOC from Pollution Board; Machinery and Equipment Selection , Role of SSI in Economic Development of India; major problem faced by SSI, MSMEs – Definition and Significance in Indian Economy; MSME Schemes, Challenges and Difficulties in availing MSME Schemes. Entrepreneurship, Support System like SIDBI, SISIs, SSIEC, SFCs, DICs, NSIC, EDI (Ahmedabad), NRDC, NIESBUD, PSIEC and Technical Consultancy Organizations. (5)

5. Rules And Legislation

Applicability of Legislation; Industries Development (Regulations) Act, 1951.;Factories Act, 1948.;The Industrial Employment (Standing Orders) Act, 1946; Suspension; Stoppage of work; Termination of employment; West Bengal Shops and Establishment Act, 1963;Environment (Protection) Act, 1986;The sale of Goods Ac, 1950 ; Industrial Dispute Act 1947Unit. (4)

6. Opportunity Identification and Product Selection

Entrepreneurial Opportunity Search &Identification; Criteria to Select a Product; Conducting Feasibility Studies; Sources of business ideas, launching a new product; export marketing,

Methods of Project Appraisal, Project Report Preparation; Project Planning and Scheduling. Sources of finance for entrepreneurs. (4)

7. Project Report

Introduction; Idea Selection; Selection of the Product / Service; Aspects of a Project; Phases of a Project; Project Report; Contents of a Project Report; Proforma of a Suggested Project Report for a manufacturing Organization. (6)

Course Outcomes:

1. Classify economic factors and their uses for decision making.
2. Characterize creative, innovative and motivational techniques.
3. Design project report on the basis of Govt. rules and regulations.
4. Characterize, analyze and design information as an entrepreneur.

Suggested Books:

1. Entrepreneurship development small business enterprises", Pearson, Poornima M Charantimath,2013.
2. Roy Rajiv, "Entrepreneurship", Oxford University Press, 2011.
3. "Innovation and Entrepreneurship",Harper business- Drucker.F, Peter, 2006.
4. "Entrepreneurship", Tata Mc-graw Hill Publishing Co.ltd new Delhi- Robert D. Hisrich, Mathew J. Manimala, Michael P Peters and Dean A. Shepherd, 8th Edition, 2012
5. Enterpreneurship Development- S.Chand & Co.,Delhi- S.S.Khanka 1999
6. Small-Scale Industries and Entrepreneurship. Himalaya Publishing House, Delhi – Vasant Desai 2003.
7. Entrepreneurship Management -Cynthia, Kaulgud, Aruna, Vikas Publishing House, Delhi, 2003.
8. Entrepreneurship Ideas in Action- L. Greene, Thomson Asia Pvt. Ltd., Singapore, 2004.

BTME-18966 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. (4)

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. (7)

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, Evaluation of inventory control performance, Concept of Just-in-Time (JIT). (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. (7)

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. (7)

Course Outcomes:

1. Demonstrate the factors affecting the material planning & budgeting.
2. Use the different techniques for inventory control.
3. Categorize and apply the different purchasing systems in industry.
4. Describe the functions and importance of storage of material.

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.

BTME-18967 Management Information System

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

Course Objectives: To introduce the concepts of decision making, data communication, database management and management information 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 system.(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 multivendor 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. (8)

4. Database Management Systems

Introduction, data base designing, relational data base management system. Introduction to computerized data base management system. (4)

Course Outcomes:

1. Classify information and use it for decision making.
2. Characterize network structures for data communication.
3. Design relational data base management system.
4. Characterize, analyze and design management information systems.

Suggested Books:

1. Information systems for Modern Management by Mudrick, Ross and Clagget Prentice Hall.
2. Management Information systems by Davis and Olson McGraw Hill
3. Information systems for management by Lucas McGraw Hill

BTME-18968 Computer Integrated Manufacturing

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

Course Objectives: To introduce the basic concepts of Automation and Computer Integrated Manufacturing and various components.

1. Manufacturing Automation

Automated Manufacturing Systems, Computerized Manufacturing Support Systems, Reasons for Automation, Automation Strategies-The USA Principle, Ten Strategies for Automation and Process Improvement, Automation Migration Strategy. (3)

2. Automated Flow lines

System Configurations, Workpart Transfer Mechanisms, Storage Buffers, Control of Production Line, Analysis of Transfer Lines-Transfer Lines with No Internal Parts Storage, Transfer Lines with Internal Storage Buffers. (4)

3. Manual Assembly Lines

Assembly Workstations, Work Transport Systems, Line Pacing, Coping With Product Variety, Analysis of Single Model Assembly Lines-Repositioning Losses, The Line Balancing Problem, Line Balancing Algorithms-Largest Candiate Rule, Kilbridge and Wester Method, Ranked Positional Weights Method. Automated Assembly Systems: System Configurations, Parts Delivery at Workstations, Applications, Quantitative Analysis of Assembly Systems- Parts Delivery System at Workstations, Multi-station Assembly machines, Single Station Assembly Machines, Partial Automation. (6)

4. Automatic Material Handling and Storage systems

Design Considerations in Material Handling, Material Transport Equipment-Industrial Trucks, Automated Guided Vehicles, Monorails and Other Rail-Guided Vehicles, Conveyors, Cranes and Hoists, Analysis of Vehicle Based Systems, Conveyor Analysis. Automated Storage/Retrieval Systems, Carousel Storage Systems, Engineering Analysis of AS/RS and Carousel Systems. Automated Inspection systems: Overview of Automated Identification Methods, Bar Code Technology, Radio Frequency Identification, Other AIDC Technologies-Mangnetic Stripes, Optical Character Recognition, and Machine Vision. (8)

5. Group Technology

Part Families, Parts Classification and Coding, Features of Parts Classification and Coding Systems, Opitz of Parts Classification and Coding Systems, Production Flow Analysis, Composite Part Concept, Machine Cell Design, Applications of Group Technology, Quantitative

analysis of Cellular Manufacturing, Grouping of parts and Machines by Rank Order Clustering, Arranging Machines in a GT Cell. (6)

6. Computer Aided Process Planning

Retrieval CAPP Systems, Generative CAPP Systems, Feature Identification- Algorithms, Graph Based Approach, Attribute Adjacency Graph, Benefits of CAPP. (4)

7. Flexible Manufacturing Systems

Flexibility, Types of FMS-A Dedicated FMS, A Random Order FMS, FMS Components-Workstations, Material Handling and Storage Systems, Computer Control System, Human Recourses, FMS Applications and Benefits. (3)

8. Computer Integrated Manufacturing

The Scope of CAD/CAM and CIM, Computerized elements of a CIM System, Components of CIM, Database for CIM, Planning, Scheduling and Analysis of CIM Systems. (2)

Course Outcomes:

1. Explain the effect of manufacturing automation strategies and derive production metrics.
2. Analyze automated flow lines and assembly systems, and balance the line.
3. Design automated material handling and storage systems for a typical production system.
4. Design a manufacturing cell and cellular manufacturing system.
5. Develop CAPP systems for rotational and prismatic parts.

Suggested Books:

1. Mikell P Groover, Automation, production Systems and Computer Integrated Manufacturing, Prentice Hall Inc., New Delhi.
2. Nanua Singh, System Approach to Computer Integrated Manufacturing, Wiley & Sons Inc.
3. Andrew Kusiak, Intelligent Manufacturing System, Prentice Hall Inc., New Jersey.