Scheme & Syllabus

B.Tech. [Mechanical Engineering]
(Batch 2022 & onward batches)

SHAHEED BHAGAT SINGH STATE UNIVERSITY,FEROZEPUR

Department of Mechanical Engineering

DEPARTMENT OF MECHANICAL ENGINEERING

(3rd - 8th Semester, B.Tech Study Scheme, 2022 Batch & onwards)

Semester III

Sr. No	Subject Code	Subject	Teaching Load			Internal and External Assessment						Credits
						Theory			Practical			
			L	T	P	Int	Ext	Total	Int	Ext	Total	
1.	BTME 301C	Strength of Materials-I	3	1	-	40	60	100	-	-	-	4
2.	BTME 302C	Theory of Machines-I	3	1	-	40	60	100	-	-	-	4
3.	BTME 303C	Basic Thermodynamics	3	1	-	40	60	100	-	-	-	4
4.	BTME 304C	Fluid Mechanics	3	1	-	40	60	100	-	-	-	4
5.	BTME 305C	Manufacturing Processes-I *	3	-	-	40	60	100	-	-	-	3
6.	BTME 306C	Strength of Material (Lab)	-	-	2	-	-	-	30	20	50	1
7.	BTME 307C	Theory of Machines (Lab)	-	-	2	-	-	-	30	20	50	1
8.	BTME 308C	Fluid Mechanics (Lab)	-	-	2	-	-	-	30	20	50	1
9.	BTME 309C	Workshop Training	-	-	4	-	-	-	60	40	100	2
		Total						**500**			**250**	**24**
		Grand Total										**750**

Semester IV

Sr. No	Subject Code	Subject	Teaching Load			Internal and External Assessment						Credits
						Theory			Practical			
			L	T	P	Int	Ext	Total	Int	Ext	Total	
1.	BTME 401C	Strength of Materials-II	3	1	-	40	60	100	-	-	-	4
2.	BTME 402C	Theory of Machines-II	3	1	-	40	60	100	-	-	-	4
3.	BTME 403C	Applied Thermodynamics	3	1	-	40	60	100	-	-	-	4
4.	BTME 404C	Machine Drawing	1	-	6	40	60	100	-	-	-	4
5.	BTME 405C	Manufacturing Processes-II **	3	-	-	40	60	100	-	-	-	3
6.	BTME 406C	Applied Thermodynamics(Lab)	-	-	2	-	-	-	30	20	50	1
7.	BTME 407C	Manufacturing Processes(Lab)	-	-	2	-	-	-	30	20	50	1
8.	BTXX XXXX	Open Elective-I	3	-	-	40	60	100	-	-	-	3
		Total						**600**			**100**	**24**
		Grand total										**700**

 # There will be Industrial Training of 4 weeks (Non- credit) after the fourth semester

***Diploma course -1 & ** Diploma course -2**

Semester V

Sr. No	Subject Code	Subject	Teaching Load			Internal and External Assessment						Credits
						Theory			Practical			
			L	T	P	Int	Ext	Total	Int	Ext	Total	
1.	BTME 501C	Heat Transfer	3	1	0	40	60	100	-	-	-	4
2.	BTME 502C	Design of Machine Elements	3	1	0	40	60	100	-	-	-	4
3.	BTME 503C	Engineering Materials and Metallurgy	3	0	0	40	60	100	-	-	-	3
4.	BTME 504C	Automobile Engineering*	3	0	0	40	60	100	-	-	-	3
5.	BTME 505C	Heat Transfer (Lab)	0	0	2	-	-	-	30	20	50	1
6.	BTME 506C	Automobile Engineering (Lab)*	0	0	2	-	-	-	30	20	50	1
7.	BTME 507C	Engineering Materials and Metallurgy (Lab)	0	0	2	-	-	-	30	20	50	1
8.	BTME 408C	Industrial Training	0	0	6		-		60	40	100	Non-Credit
9.	BTME 51X C	Departmental Elective-I	3	0	0	40	60	100	-	-	-	3
10.	BTXX XXX X	Open Elective-II	3	0	0	40	60	100	-	-	-	3
		Total						**600**			**250**	**23**
		Grand Total										**850**

***Advance Diploma course -1**

Departmental Elective Subjects

5th Semester (DE -I)

1. BTME 511C Internal Combustion Engines
2. BTME 512C Maintenance and Reliability
3. BTME 513C Operations Research
4. BTME 514C Plant Layout & Material Handling
5. BTME 515C Energy Conservation and Management
6. BTME 516C Numerical Methods in Engineering

Semester VI

Sr. No.	Subject Code	Subject	Teaching Load			Internal and External Assessment						Credits
						Theory			Practical			
			L	T	P	Int	Ext	Total	Int	Ext	Total	
1.	BTME 601C	Refrigeration & Air-conditioning	3	1	0	40	60	100	-	-	-	4
2.	BTME 602C	Fluid Machinery	3	0	0	40	60	100	-	-	-	3
3.	BTME603C	Mechanical Measurements and Metrology**	3	0	0	40	60	100	-	-	-	3
4.	BTME 604C	Refrigeration & Air-conditioning (Lab)	0	0	2	-	-	-	30	20	50	1
5.	BTME 605C	Fluid Machinery (Lab)	0	0	2	-	-	-	30	20	50	1
6.	BTME 606C	Mechanical Measurements and Metrology Lab**	0	0	2				30	20	50	1
7.	BTME 61XC	Departmental Elective-II	3	0	0	40	60	100	-	-	-	3
8.	BTXX XXXX	Open Elective-III	3	0	0	40	60	100	-	-	-	3
9.	BTHU 901C	Personality Development	3	0	0	40	60	100	-	-	-	3
		Total						**600**			**150**	**22**
		Grand total										**750**

****Advance Diploma course -2**

Departmental Elective Subjects

6th Semester (DE –II)

1. BTME 611C Product Design and Development
2. BTME 612C Quality Control and Six Sigma
3. BTME 613C Mechatronics
4. BTME 614C Non Traditional Machining
5. BTME 615C Power Plant Engineering
6. BTME 616 C Total Quality Management

Semester VII

Sr. No	Subject Code	Subject	Teaching Load			Internal and External Assessment						Credits
						Theory			Practical			
			L	T	P	Int	Ext	Total	Int	Ext	Total	
1.	BTME 701C	Mechanical Vibrations	3	1	0	40	60	100	-	-	-	4
2.	BTME 702C	CAD/CAM	3	0	0	40	60	100	-	-	-	3
3.	BTME 703C	Mechanical Vibrations (Lab)	0	0	2	-	-	-	30	20	50	1
4.	BTME 704C	CAD/CAM (Lab)	0	0	2	-	-	-	30	20	50	1
5.	BTME 705C	Project	0	0	8	-	-	-	60	40	100	4
6.	BTME 71XC	Department Elective III	3	0	0	40	60	100	-	-	-	3
7.	BT XX XXXX	Open Elective IV	3	0	0	40	60	100	-	-	-	3
8.	BTHU 902C	Human Resource Management	3	0	0	40	60	100	-	-	-	3
		Total						**500**			**200**	**22**
		Grand total										**700**

Departmental Elective Subjects

7th Semester (DE - III)

BTME 711C Production Planning & Control

BTME 712C Composite Materials

BTME 713C Industrial Automation & Robotics

BTME 714 C Statistical Quality Control

BTME 715 C Advanced Techniques in Manufacturing

BTME 716 C Finite Element Methods

Semester VIII (a)*

Sr. No	Subject Code	Subject	Teaching Load			Internal and External Assessment						Credits
						Theory			Practical			
			L	T	P	Int	Ext	Total	Int	Ext	Total	
1.	BTME 801C	Industrial Safety and Environment	2	0	0	40	60	100	-	-	-	2
2.	BTME 81XC	Department Elective IV	3	0	0	40	60	100	-	-	-	3
3.	BTME 81XC	Department Elective V	3	0	0	40	60	100	-	-	-	3
4.	BTME 81XC	Department Elective VI	3	0	0	40	60	100	-	-	-	3
5.	BTXXXXXX	Open Elective V	3	0	0	40	60	100				3
		Total									**500**	**14**

Semester VIII (b)*

Sr. No	Subject Code	Subject	Assessment criteria Internal		External	Total Marks	Credits
			Institute	Industry			
1.	BTME 802C	Industrial Training	100	50	100	250	14
		Software Training	100	50	100	250	
		Total	200	100	200	**500**	**14**

***In the VIII Semester student can have the option to choose VIII (a) or VIII (b).**

Departmental Elective Subjects

8th Semester (DE – IV to VI)

BTME 811C Non Destructive Testing
BTME 812C Industrial Tribology
BTME 813C Management Information System
BTME 814 C Industrial Engineering
BTME 815 C Jigs, Fixture and Tool Design
BTME 816 C Renewable Energy Resources
BTME 817 C Work Study and Ergonomics
BTME 818 C Material Management

3rd

SEMESTER

BTME 301C: STRENGTH OF MATERIALS-I

Semester	III					
Course code	BTME 301 C					
Category	Professional Core Courses (B.Tech. ME)					
Course title	Strength of Materials-I (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	1	0	40	60	04

COURSE OBJECTIVES

The course is designed to understand the basic concepts of stress, strain and their variations due to different type of loading. The concept of Mechanical properties, Poisson's ratio, bulk modulus, elastic modulus, modulus of rigidity, combined stress and strain, principal stress, principal plane, bending moment and shear force in beam under various loading conditions, Understanding of torsional shear stress in solid and hollow shaft; principal and maximum shear stress in a circular shaft subjected to combined stresses, stresses in struts and columns subjected to axial load; bending stress, slope and deflection under different loading and supporting conditions.

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Understand the concepts of stress and strain at a point as well as the stress-strain relationships for homogenous, isotropic materials.
2. Analyze and design structural members subjected to tension, compression, torsion, bending and combined stresses using the fundamental concepts of stress, strain and elastic behavior of materials.
3. Tackle the problems related to shearing Force, bending moment, slope and deflections in different types of beams subjected to various types of loadings.
4. Determine and illustrate principal stresses, maximum shearing stress, and the stresses acting on a structural member.
5. Understand the concept of buckling of slender, long columns subjected to axial loads and be able to solve problems related to columns and struts.

1. **Simple 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. **(8 Hrs)**

2. **Compound Stresses**: Two-dimensional stress system, stress at a point on a plane, principal stresses and principal planes, Mohr's circle of stress. Generalized Hook's law, principal stresses related to principal strains. **(6 Hrs)**
3. **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 different loads: Concentrated loads, Uniformity distributed loads over the whole span or part of span, Combination of concentrated and uniformly distributed load, Uniformly varying loads and Application of moments. **(5 Hrs)**
4. **Bending Stresses in Beams**: Derivation of Bending formula and assumptions made. Applications of Bending Formula to beams of rectangular, circular and channel, I and T-sections. Combined direct and bending stresses in afore-mentioned sections, composite /flitched beams. **(5 Hrs)**
5. **Slope and Deflection**: Relationship between moment, slope and deflection; Double integration method, Macaulay's method, Moment-Area method and use of these methods to calculate slope and deflection for: Cantilevers, Simply supported beams with or without overhang, Under concentrated loads, uniformly distributed loads or combination of concentrated and uniformly distributed loads. **(6 Hrs)**
6. **Torsion**: Derivation of Torsion equation and assumptions made. Applications of Torsion equation 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 Hrs)**
7. **Columns and Struts**: Introduction, Classification and failure of columns, Euler's formula, Rankine-Gordon's formula for axially loaded columns and their applications. **(5Hrs)**

SUGGESTED TEXT/REFERENCE BOOKS:

1. Egor.P.Popov, " Mechanics of Materials", Prentice Hall of India, New Delhi
2. Timoshenko and Gere, "Mechanics of Materials", CBS Publishers and Distributors, New Delhi.

3. Pytel and Kiusalaas, “Mechanics of Materials”, Cengage Learning, New Delhi.
4. S. S. Rattan, “Strength of Materials”, Tata McGraw Hill, New Delhi.
5. Kirpal Singh, “Mechanics of Materials”, Standard Publishers, New Delhi.
6. Sadhu Singh, Strength of Materials, Khanna Publishers, Delhi.
7. R. K. Bansal, “A Text Book of Strength of Materials”, Laxmi Publications, New Delhi.
8. Abdul Mubeen, “Mechanics of Solids”, Pearson Education, New Delhi

BTME 302C: THEORY OF MACHINES-I

Semester	III					
Course code	BTME 302 C					
Category	Professional Core Courses (B.Tech. ME)					
Course title	Theory of Machines-I (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	1	0	40	60	04

COURSE OBJECTIVES

The course objectives of Theory of Machines encompass a comprehensive study of mechanical systems, kinematics and dynamics. The students delve into the principles governing the motions, velocity and acceleration of machine elements & mechanisms by analysing various linkages and machine components; they gain insights into their behaviour and features. Moreover, the course delves into the forces and movements effecting machine components, imparting a deeper understanding on their effects on motion. Furthermore, the course covers the focus on cams and follower mechanisms, belts, chains, flywheel & governor and their motion control, the course equips students with the necessary expertise to analyse and design mechanical systems for diverse engineering applications.

COURSE OUTCOMES

At the end of the course the students will be able to:

1. Understand various types of mechanisms used in real-world machines and their applications in different industries.
2. Analyze and describe the motion of various machine components and mechanisms, using methods like velocity, acceleration, displacement, and angular velocity analysis
3. Familiarize students with the different components of machines and mechanisms, such as belts, ropes, chains, cams and followers with their respective functions.
4. Study the frictional forces and torques acting on machine components, and analyzing the effects of these forces on the motion and stability of machines.
5. Illustrate the combined application of flywheels and governors in practical mechanical systems to achieve stable and efficient operation.

1. **Basic Concepts:** Kinematics of machine, Kinematic link and their different types, types of kinematic pair, kinematic chain, mechanism and inversions of four bar chain and slider Crank mechanism. Degree of freedom, synthesis of linkages – number synthesis, Grashof's Criterion and introduction to dimensional synthesis. **(7 hrs)**

2. **Velocity and Acceleration Analysis:** Motion of a link, velocity of a point on a link by relative velocity method, Velocities of slider crank mechanisms, rubbing velocity at a pin joint, velocity of a point on a link by instantaneous center method, properties and types of I-Center, Kennedy theorem and methods of locating I-centers in a mechanism. Acceleration of a link, its slider Crank and Quick-return mechanism. **(7 hrs)**
3. **Belt, Rope and Chain Drive:** Types of belt drives, velocity ratio, law of belting, length of belt, ratio of friction tensions, power transmitted, effect of centrifugal tension on power transmission, concept of ropes, condition for maximum power transmission, concept of slip and creep. Chain drives, chain length and angular speed ratio. **(6 hrs)**
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 acceleration and retardation, cycloidal). Study of tangent cam profiles and its pressure angle. **(5 hrs)**
5. **Friction Devices**: Concepts of frictions and wear related to bearing and clutches. Types of clutches and principle of different brakes. Braking of front and rear tyres of a vehicle, Problems to determine braking capacity, Types of dynamometers, (absorption, transmission). **(5 Hrs)**
6. **Flywheels:** Turning moment and crank effort diagrams for reciprocating machines. Fluctuations of speed, coefficient of fluctuation of speed and energy, Determination of energy stored in flywheel for engines and Punching Machines. **(5 hrs)**
7. **Governors:** Different types of Centrifugal and Inertia Governors: Watt, Porter, Proell, Hartnell, Wilson Hartnell, concepts of hunting, Isochronism, Stability, effort and power of governor and controlling force. **(5 hrs)**

SUGGESTED TEXT/REFERENCE BOOKS

1. Jagdish Lal, Theory of Mechanisms & Machines, Metropolitan Book Co. Pvt. Ltd, New Delhi.
2. R.S. Khurmi, J.K. Gupta, Theory of Machines, S. Chand & Company Ltd., New Delhi.
3. S. S. Rattan, Theory of Machines, Tata McGraw Hill, New Delhi.
4. Thomas Beven, Theory of Machines, Longman's Green & Co., London.
5. W. G. Green, Theory of Machines, Blackie & Sons, London5. Shigley, Theory of Machines, Mcgraw Hill, New York.

BTME 303C: BASIC THERMODYNAMICS

Semester	III					
Course code	BTME 303 C					
Category	Professional Core Courses (B.Tech. ME)					
Course title	Basic Thermodynamics (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	1	0	40	60	04

COURSE OBJECTIVES

This course aims to provide knowledge to mechanical engineering students to understand the fundamentals of thermodynamics including thermodynamic systems and properties, the laws of thermodynamics and applications of these basic laws in thermodynamic systems, to learn about gas power cycles with basics of I.C. engines, to learn about steam formation and its properties.

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Explain fundamental thermodynamic properties.
2. Explain the concepts of work, power, and heat in thermodynamics; determine work and heat sign conventions; determine work involved with moving boundary systems
3. Explain Zeroth, First and Second laws of thermodynamics.
4. Apply the First law of thermodynamics for a control volume, including with turbines, compressors, nozzles, diffusers, heat exchangers, and throttling devices.
5. Perform energy analysis of heat engine, refrigeration, heat pump and gas power cycles.
6. Explain causes of irreversibility, the Carnot heat engine cycle, concept of entropy, including the Clausius Inequality.
7. Determine thermodynamic properties of pure substances.

1. Fundamental Concepts and Definitions

Introduction and definition of thermodynamics, Concept of continuum, Systems, surroundings and universe, Properties and state, Thermodynamic path, process and cycle, Thermodynamic equilibrium, Reversible process, Quasi-static process, Concept of continuum, Energy and its forms, Thermodynamic work, Non-flow work and flow work, calculation of work, Heat, Specific Heat and Latent Heat, Path function and Point

function, Zeroth Law of Thermodynamics, Temperature measurement and Temperature scales. **(6 hrs)**

2. First Law of Thermodynamics and it's applications

First law of thermodynamics for a closed system undergoing a cycle, First law of thermodynamics for a closed system undergoing change of state, Energy-A Property of the System, Internal energy and enthalpy, Specific heats and their relation with internal energy and enthalpy, Analysis for change in various properties, Heat exchange, work done of various non-flow processes for a ideal gas, First law of thermodynamics applied to open systems, Control volume, Steady flow process, Mass and Energy balance in simple steady flow process, First law applied to engineering systems i.e. Nozzle and Diffuser, Throttling process, Turbine and Compressor, Heat Exchanger. **(7 hrs)**

3. Second Law of Thermodynamics and it's applications

Limitations of First law of thermodynamics, Heat reservoir, Heat Engine, Refrigerator, Heat Pump, Kelvin-Planck and Clausius statements of Second law of thermodynamics and their equivalence, Causes of irreversibility, Carnot cycle and Carnot engine, Carnot theorem and its corollaries, Absolute Thermodynamic temperature scale, Entropy – A property of system, Clausius inequality, Principle of entropy increase, Entropy change during different thermodynamic processes, Entropy and its relevance, Concept of entropy generation in closed and open systems, high grade and low grade energy, Available and Unavailable energy, Availability and Unavailability, Second law efficiency and energy analysis of Thermodynamic systems, Third law of thermodynamics (Definition only). **(7 hrs)**

4. Thermodynamic Properties of Pure Substance

Pure Substance, Properties and important definitions, Phase transformation process, p-v, p-T and T-s diagram and p-v-T surfaces for a pure substance, Properties of steam, Steam tables and Mollier diagram and their use for various processes i.e. constant volume, constant pressure, isentropic processes, Dryness fraction measurement **(6 hrs)**

5. Gas Power Cycles

Philosophy of Air-standard cycles, Air standard efficiency, An overview of piston-cylinder based engines to understand terms i.e. swept volume; clearance volume; compression ratio; mean effective pressure etc., Otto cycle, Diesel cycle, Dual cycle, Comparison of Otto, Diesel and Dual cycles, An overview of Gas turbine, Brayton cycle (constant pressure gas turbine cycle), Brayton cycle with thermal refinements i.e. intercooling, reheating, regeneration. **(6 hrs)**

6. Preliminary of Internal Combustion Engines

Classification, Applications, Constructional details and working of two stroke and four stroke internal combustion engines based on the ideal mechanical cycle. **(4 hrs)**

SUGGESTED TEXT/REFERENCE BOOKS

1. Y. A. Cengel; M. A. Boles; Thermodynamics – An Engineering Approach; Tata McGraw Hill Education Pvt. Ltd. New Delhi.
2. P. K Nag; Engineering Thermodynamics; Tata McGraw Hill Education Pvt. Ltd.; New Delhi.
3. G. V. Wylen; R. Sonntag, C. Borgnakke; Fundamentals of Classical Thermodynamics; John Wiley & Sons.
4. Mahesh M. Rathore; Thermal Engineering; Tata McGraw Hill Education Pvt. Ltd.; New Delhi.
5. Onkar Singh; Applied Thermodynamics; New Age International Publisher

BTME 304C: FLUID MECHANICS

Semester	III					
Course code	BTME 304 C					
Category	Professional Core Courses (B.Tech. ME)					
Course title	Fluid Mechanics (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	1	0	40	60	04

COURSE OBJECTIVES

This course has been designed for students to have conceptual understanding of fluids and their properties applicable to various relevant applications. The motive is also to develop the basic understanding of fluids behavior at rest and in motion. The students will have the knowledge of various laws of fluid mechanics and learn to apply these laws to solve different types of problems related to fluid flow measurement devices.

COURSE OUTCOMES

After successful completion of this course the students will have:

1. Basic understanding about fluids and their properties.
2. Understanding of behaviour of fluids in state of rest and during flow.
3. Apply laws and principles of fluid mechanics to solve different types of problems related to fluid flow.
4. Learn model and prototype similarity and apply dimensional analysis.
5. Analyze the flow through fluid flow measurement devices.

1. Fundamentals of Fluid Mechanics

Introduction to fluid mechanics and its applications, Concept of fluid, Difference between solids and fluids, Concept of continuum, Ideal and real fluids. Fluid properties: density, specific volume, specific weight, specific gravity, Dynamic and kinematic viscosity, Newton's Law of viscosity, Vapour pressure, compressibility and bulk modulus, Mach number, Phenomenon of surface tension and capillarity, Newtonian and Non-Newtonian fluids.

4 Hrs

2. Fluid Statics

Concept of static fluid pressure, Pascal 's Law and its engineering applications, Action of fluid pressure on plane submerged surfaces (horizontal, vertical and inclined), Total pressure force and centre of pressure, Force on a curved surface due to hydrostatic pressure, Buoyancy and flotation, Stability of floating and submerged objects, Metacentric height and its

determination, Pressure distribution in a liquid subjected to constant acceleration along horizontal, vertical and inclined direction with linear motion and constant rotation **6 Hrs**

3. Fluid Kinematics

Classification of fluid flows, Lagrangian and Euler flow descriptions, Velocity and acceleration of a fluid particle, Local and convective acceleration, Normal and tangential acceleration, Pathline, streakline, streamline and timelines, flow rate and discharge, mean velocity, one dimensional continuity equation, continuity equation in Cartesian coordinates, Derivation of continuity equation using the Lagrangian method in Cartesian coordinates, Rotational flows, rotation, vorticity and circulation, stream function, velocity potential function, relationship between stream function and velocity potential function, Flow net **6 Hrs**

4. Fluid Dynamics

Derivation of Euler's equation of motion in Cartesian coordinates and along the streamline, Derivation of Bernoulli's equation using principle of conservation of energy and equation of motion and its application to steady state ideal and real fluids, Impulse momentum equation, Kinetic energy and momentum correction factors, flow along a curved streamline, Free and forced vortex motions **6 Hrs**

5. Laminar and Turbulent flow

Laminar and turbulent flow through pipes, Reynolds Experiment, Loss of head through pipes, Darcy-Weisbach equation, Minor and Major energy losses, Representation of energy changes in fluid system - hydraulic and total energy gradient line, Pipes in series and pipes in parallel, equivalent pipes **5 Hrs**

6. Dimensional Analysis and Similitude

Need of dimensional analysis, Fundamental and derived units, Dimensional analysis and dimensional homogeneity, Rayleigh's and Buckingham's Л- method for dimensional analysis, Dimensionless numbers and their significance, Need of similitude, kinematic and dynamic similarity, Model and prototype studies, Similarity model laws **5 Hrs**

7. Pressure and Flow measurement

Manometers, Pitot tubes, various hydraulic coefficients, orificemeter, Venturimeter, orifices and mouthpieces, Notches and weirs, Rotameter **4 Hrs**

SUGGESTED TEXT/REFERENCE BOOKS:

1. D.S.Kumar, Fluid Mechanics and Fluid Power Engineering, S.K.Kataria and sons publication
2. S.K.SOM, G.Biswas and S.K. Chakraborty, Introduction to Fluid Mechanics and Machinery,

Tata McGraw Hill

3. C.S.P. Ojha,R.Berndsson and P.N. Chandermouli, Fluid Mechanics and Machinery, Oxford University Press
4. Y.A.Cengel and J.M.Cimbala, Fluid Mechanics: Fundamentals and Applications, Tata McGraw Hill
5. J.F.Douglas and J.M.Gasiorek,J.A. Swaffield and L.B. Jack, Fluid Mechanics, Pearson Publications
6. V.L. Streeter,E.B.Wylie and K.W. Bedford, Fluid Mechanics , Tata McGraw Hill
7. R.K.Bansal, Fluid Mechanics and Hydraulic Machines, Laxmi Publications
8. P.N.Modi and S.M. Seth, Hydraulics and Fluid Mechanics, Rajson Publications

BTME 305 C: MANUFACTURING PROCESSES-I

Semester	III					
Course code	BTME 305 C					
Category	Professional Core Courses (B.Tech. ME) - Diploma Course					
Course title	Manufacturing Processes-I (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

COURSE OBJECTIVES

1. To familiarize the students with the basic tools and equipment's used in manufacturing.
2. To introduce the practical knowledge on different aspects of manufacturing processes.
3. To familiarize with basic manufacturing processes, techniques, use of machine tool etc.
4. To familiarize with the production of basic raw materials and secondary processes like joining, forming, and assembly.

COURSE OUTCOME

By the end of this course, the student will be able to:

1. Understand the concept of manufacturing, product design, selection of raw materials.
2. Plan and apply the different manufacturing processes to fabricate the ferrous, nonferrous and composite materials.
3. Analyse the possible defects of manufacturing processes and ability to rectify the defects.
4. Ability to select and apply the suitable manufacturing processes to make desire feature of products.
5. Estimation pouring and solidification time of metal casting.
6. Design and adapt different gating system, runner and riser to cast product/parts for different industry.

1. **Foundry**: Raw materials: fuels, refractory and related materials, patterns, mould, core;
2. **Furnaces:** Cupola, induction and resistance heating furnaces, core furnace, open hearth furnace, pit furnace,
3. **Sand Casting** : Design: Gating system, runner and riser; Pouring time calculation, Degassing, Fettling;

4. **Special Castings**: Centrifugal, carbon dioxide, plaster, shell and permanent moulding, precision casting, investment casting, die casting, Continuous casting; Casting defects: Causes and their remedial actions.
5. **Welding:** Definition, classification, mechanism of welding, weldability.
6. **Arc Welding:** Principle, types, Carbon, submerged, electro-slag, MIG and TIG. Electrodes: Types, classification and codification, selection and specific applications.
7. **Resistance Welding**: Principle, types, Spot-welding machines. Solid state welding: Cold, diffusion, ultrasonic, friction and forge welding.
8. **Gas Welding:** Types, different zone and temperature of flames, applications. Oxy-flame cutting: Principle, types, applications. Brazing and soldering: Principle, types, materials, application in macro and micro domain. Welding defects: Causes and remedial actions.
9. **Heat Treatment**: Definition, classification, annealing, normalizing, hardening and tempering; Iron-carbon and TTT diagram, Surface hardening processes: carburizing, nitiriding, cyaniding and flame hardening.

SUGGESTED TEXT/REFERENCE BOOKS:

1. Principles of Manufacturing Materials and Processes; Campbell-Tata McGraw Hill.
2. Fundamentals of Modern Manufacturing, Mikell P. Groover.
3. Manufacturing Processes, P.C. Sharma, S. Chand Publication
4. Manufacturing Processes Vol I , OP Khanna, S Chand Publication

BTME 306C: STRENGTH OF MATERIALS LAB

Semester	III					
Course code	BTME 306 C					
Category	Professional Core Courses (B.Tech. ME)					
Course title	Strength of Materials Lab (Practical)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	0	0	2	30	20	01

COURSE OBJECTIVES

The course is designed to understand the basic concepts of tensile stress, compressive stress, strain, hardness, Impact strength, fatigue and creep. The concept of Mechanical properties, Poisson's ratio, bulk modulus, elastic modulus, modulus of rigidity, bending stresses in beam, Understanding of torsion, shear stress, failure of ductile brittle material under torsion, Failure of struts and columns under various end conditions. Various types of spring under axial loads.

COURSE OUTCOMES

After studying this course, students shall be able to:

1. Measure the various mechanical properties such as tensile and compressive strength, impact strength, torsion strength and fatigue strength and hardness of brittle and ductile materials.
2. Calculate load carrying capacity of long columns and their buckling strength.

LIST OF PRACTICALS

1. To determine various mechanical properties of Ductile and Brittle materials by performing tensile and compression test and draw stress-strain curve.
2. To perform any hardness tests (Any two from Rockwell, Brinell and Vicker's test) and determine the hardness number of a given material.
3. To determine impact strength of given material by performing impact test (Charpy and Izod).
4. To perform torsion test and determine various mechanical properties of ductile and brittle materials.
5. To perform bending test on a given beam and determine the Young's modulus and maximum Bending Stress.
6. Determination of Bucking loads of long columns with different end conditions.
7. To determine the Modulus of Rigidity and Stiffness of a helical spring under tensile and compression loadings.
8. Overview of Fatigue and Creep test for a material. Study of Fatigue and Creep Strength.

SUGGESTED TEXT/REFERENCE BOOKS

1. B.M. Ravel, "Experiments in Mechanics of Solids" Charotar Publishing House, Anand, India
2. C. B. Kukreja and V.V. Sastry, "Experimental Methods in Structural Mechanics", Standard Publishers Distributers, New Delhi
3. Abdul Mubeen, "Experimental Strength of Materials", Khanna Publishers, New Delhi.

BTME 307C: THEORY OF MACHINES LAB

Semester	III					
Course code	BTME 307 C					
Category	Professional Core Courses (B.Tech. ME)					
Course title	Theory of Machines Lab (Practical)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	0	0	2	30	20	01

COURSE OUTCOMES

1. Provide students with practical exposure to various mechanisms and machines, allowing them to apply theoretical concepts in a real-world context
2. Develop skills to analyze and evaluate the kinematic and dynamic behavior of different mechanisms, including their velocities, accelerations, and forces.
3. Familiarize students with different machine components such as cams, linkages, and bearings, enabling them to comprehend their functionality, interactions, and applications.

LIST OF PRACTICALS

1. Study of Kinematics of Four Bar, Slider Crank, Crank Rocker, Double crank, Double rocker, Oscillating cylinder Mechanisms.
2. Study and draw various inversions of 4- bar chain and single slider crank chain.
3. Draw velocity and diagram of engine mechanism using graphical methods including Klein's construction.
4. Study pressure distribution in a full journal bearing.
5. Determination vibration characteristics of free and forced spring mass system with and without damping.
6. Study of Cam profiles (graphical method), motion curves and jump phenomenon.
7. Determination of Mass moment of Inertia of Fly wheel & Axle system.
8. Determination of range sensitivity, effort etc., for Watts, Porter, Proell, and Hartnell Governors.

*Apart from above experiments Numerical problem / assignment may also be taken up during lab session.

BTME 308C: FLUID MECHANICS LAB

Semester	III					
Course code	BTME 308 C					
Category	Professional Core Courses (B.Tech. ME)					
Course title	Fluid Mechanics (Practical)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	0	0	2	30	20	01

COURSE OUTCOMES

After successful completion of the course the students will have the knowledge for determination of:

1. Different types of fluid flows.
2. Various flow measurement devices and measurement methods.
3. Minor and major energy losses for flow through the pipes.

LIST OF PRACTICALS

1. To determine the Metacentric height of a floating vessel under loaded and unloaded condition
2. To study the flow through the variable duct and to verify the Bernoulli's equation.
3. To determine the coefficient of discharge for a venturimeter
4. To determine the coefficient of discharge for an orificemeter
5. To determine the coefficient of discharge for a V-notch or a rectangular Notch
6. To determine the friction coefficients for pipes of different diameters
7. To determine the head losses in a pipe line due to sudden expansion, sudden contraction or bend.
8. To determine the velocity distribution for pipeline flow with a pitot tube
9. To study the transition from laminar to turbulent flow and to determine lower critical Reynold number
10. To determine the hydraulic coefficients for flow through an orifice.

BTME 309C: WORKSHOP TRAINING

Semester	III					
Course code	BTME 309 C					
Category	Professional Core Courses (B.Tech. ME)					
Course title	Workshop Training (Practical)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	0	0	4	60	40	02

COURSE OUTCOMES

Upon completion of this course, the students will gain knowledge of the different manufacturing processes which are commonly employed in the industry to fabricate components using different materials. After completion of this laboratory course, students will be able to fabricate components with their own hands. They will also get practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes. Assembling different components, they will be able to produce small devices of their interest.

Workshop Practice (60 hours) **[L: 0; T: 0; P: 4 (2 credits)]**

1. Machine shop (10 hours)
2. Fitting shop (8 hours)
3. Carpentry (6 hours)
4. Electrical & Electronics (8 hours)
5. Welding shop (8 hours (Arc welding 4 hrs + gas welding 4 hrs)
6. Casting (8 hours)
7. Smithy (6 hours)
8. Plastic moulding & Glass Cutting (6 hours)

Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

SUGGESTED TEXT/REFERENCE BOOKS:

1. Swarn Singh: Workshop Practice: S K Kataria & Sons
2. R.K Singal: Workshop Practice: S K Kataria & Sons
3. Prof. Veeranna: Workshop/Manufacturing Practice: Khanna Publishers
4. H S Bawa: Workshop Practice: PHI Publisher

4th SEMESTER

BTME 401C: STRENGTH OF MATERIALS-II

Semester	IV					
Course code	BTME 401C					
Category	Professional Core Courses (B.Tech.ME)					
Course title	Strength of Materials-II (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	1	0	40	60	04

COURSE OUTCOMES:

At the end of the course, the student will be able to:

1. Understand the vigorous stress analysis in various machine elements like cylinder, spring, curved beams, disc, ring etc.
2. Properly analyze and design a mechanical member from strength point of view under various loading conditions such as Shear Force, Bending Moments, and Rotational Force etc.
3. Solve or tackle the problems related to strain energy, bending stresses in curved structures, complex stresses and shearing stress.
4. Apply the knowledge of various theories of failures to design the various mechanical components subjected to different types of loadings.
5. Analyze and design thin and thick-walled pressure vessels subjected to various types of loading conditions.

1. **Strain Energy:** Introduction to strain energy. Strain energy in a bar under tension or compression, strain energy in a circular shaft under torsion. Strain energy in pure bending. Strain energy in three-dimensional stress field. Energy of dilation and distortion. Stress due to suddenly applied loads. Castigliano's and Maxwell's theorem of reciprocal deflection.

(08 Hrs)

2. **Theories of Failure:** Maximum principal stress theory, maximum shear stress theory, maximum principal strain theory, total strain energy theory, shear strain energy theory. Graphical representation and derivation of equation for these theories and their application to problems related to two-dimensional stress systems. **(05 Hrs)**
3. **Thin Cylinders and Spheres:** Calculation of Hoop stress, Longitudinal stress in a thin cylinder, effects of joints, change in diameter, length and internal volume. Principal stresses in sphere, change in diameter and internal volume. **(04 hrs)**

4. **Thick Cylinders:** Derivation of Lame's equations, calculation of radial, longitudinal and hoop stresses and strains due to internal pressure in thick cylinders, compound cylinders, shrinkage allowance and shrinkage stress. **(08 Hrs)**
5. **Rotational Stresses:** Stresses in rotating rims/ring and discs of uniform thickness; disc of uniform strength and its importance. **(04 hrs)**
6. **Bending of Curved Beams:** Winkler-Back Formula for initially curved beams. Calculation of stresses in cranes hooks, Circular rings subjected to axial loading and chain links with straight sides. **(05 Hrs)**
7. **Springs:** Leaf spring, Spring of Uniform Strength, deflection, bending stress and energy stored in a multi-leaf spring. Closed and Open coiled helical springs under the action of axial load and/or couple. Understanding of Stiffness, Spring Index and Helix angle in helical springs. Flat spiral springs- derivation of formula for strain energy, maximum stress and rotation **(08 Hrs)**
8. **Shear Stresses in Beams:** Shear Stress Formula. Shear stress distribution in rectangular, circular, triangular, I, T and channel section. Shear centre and its importance. **(06 hrs)**

SUGGESTED TEXT/REFERENCE BOOKS:

1. Egor.P.Popov, " Mechanics of Materials", Prentice Hall of India, New Delhi
2. Timoshenko and Gere, "Mechanics of Materials", CBS Publishers and Distributors, New Delhi.
3. G.H. Ryder, "Strength of Materials", Macmillan India Pvt. Ltd., New Delhi.
4. Edward F. Byars and Robart D Snyder, "Engineering Mechanics of Deformable Bodies", International Textbook Company, USA.
5. S. S. Rattan, "Strength of Materials", Tata McGraw Hill, New Delhi.
6. R. K. Bansal, "A Text Book of Strength of Materials", Laxmi Publications, New Delhi.
7. Kirpal Singh, "Mechanics of Materials", Standard Publishers, New Delhi.
8. Sadhu Singh, Strength of Materials, Khanna Publishers, Delhi

BTME 402 C: THEORY OF MACHINES-II

Semester	IV					
Course code	BTME 402 C					
Category	Open Elective (B.Tech)					
Course title	Theory Of Machines-II **(** (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	1	0	40	60	04

COURSE OBJECTIVES:

This subject aims to impart a fundamental understanding of dynamics of machines, helping students to grasp the forces and torques at work during machine operations by introducing the students to concepts like balancing in different situations. It further develops the analysis of complex mechanisms, such as gears, and linkages, enabling students to comprehend their behavior and applications. Gyroscopic motion and Kinematic synthesis considerations are integrated into the curriculum, promoting responsible engineering practices.

COURSE OUTCOMES: At the end of the course the students will be able to:

1. Understand the basic concepts of inertia forces & couples applied to reciprocating parts of a machine.
2. Understand balancing of rotating and reciprocating parts of machines.
3. Select suitable type of gears for different application and analyse the motion of different elements of gear trains.
4. Understand the concept and application of gyroscopic effect.
5. Gain knowledge of kinematic synthesis.

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. 05 Hrs
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. 05 Hrs

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. 06 Hrs
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. 07 Hrs
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. 05 Hrs
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. 03 Hrs
7. **Kinematic synthesis of Mechanism:** Freudenstien equation, Function generation errors in synthesis, two- and three-point synthesis Transmission angles, least square technique. 05 Hrs

RECOMMENDED BOOKS:

1. S.S. Rattan Theory of Machine Tata McGraw Hill
2. John, Gordon and Joseph Shigley,Theory of Machine and Mechanism, Oxford University Press
3. VP Singh, Theory of Machine,Dhanpat Rai & Sons
4. Jagdish Lal, Theory of Mechanisms & Machines, Metropolitan Book Co. Pvt. Ltd, New Delhi.
5. Sadhu Singh , Theory of Machine, Dorling Kindersley,Newyork
6. Thomas Bevan, Theory of Mechines,Pearson Publications

BTME 403C: APPLIED THERMODYNAMICS

Semester	IV					
Course code	BTME 403C					
Category	Professional Core Course (B.Tech.ME)					
Course title	Applied Thermodynamics (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	1	0	40	60	04

COURSE OBJECTIVES:

This course aims to create awareness to mechanical engineering students to apply the laws and concepts of thermodynamics in processes/cycles/system of steam, vapour power cycles, steam nozzles, steam turbines, steam condensers and reciprocating air compressors with their performance analysis. The student will learn about combustion phenomenon in boilers and I.C. engines.

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

1. Understand and analyze combustion of fuels in boilers and I.C. engines.
2. Apply thermodynamic concepts to analyze the performance of vapour power cycles with use of steam tables and Mollier chart.
3. Explain and analyze performance steam nozzles, steam turbines, steam condensers.
4. Learn about functioning and performance analysis of reciprocating compressors with and without intercooling.

1. Thermodynamics of Combustion in Boilers and I.C. Engines

Principle of Combustion; Stoichio-metric and non-stoichiometeric combustion; Combustion Problems in boilers & IC Engines; Calculations of air fuel ratio: Analysis of products of combustion, conversion of volumetric analysis into gravimetric analysis and vice versa, Actual weight of air supplied, use of mols. for solution of combustion problems; Heat of formation; Enthalpy of formation; Enthalpy of reaction/combustion and it's evaluation; first law analysis of reacting system: steady flow and Closed Systems, adiabatic flame temperature and its determination. Various stages of combustion in IC Engines. **(6 hrs)**

2. Review of Steam as Pure Substance:

Properties of Steam; wet, dry and super-heated steam; Sensible heating and latent heating; degree of superheat and degree of sub-cool; Enthalpy, Entropy and Internal energy of steam;

Use of Steam Tables and Mollier Charts with Basic thermodynamic processes (isochoric, isobaric, isothermal, isentropic and adiabatic processes) and their representation on T-S Charts and Mollier Charts(*h-s* diagrams), significance of Mollier Charts. **(4 hrs)**

3. **Vapour Power Cycles**

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

(7 hrs)

4. **Steam Nozzles**

Definition, types and utility of nozzles; Flow of steam through nozzles; Condition for maximum discharge through nozzle; Critical pressure ratio, its significance and its effect on discharge; Areas of throat and at exit for maximum discharge; Effect of friction; Nozzle efficiency; Convergent and Convergent-divergent nozzles. Calculation of Nozzle dimensions(length and diameters of throat and exit); Supersaturated (or metastable) flow through nozzle. **(6 hrs)**

5. **Steam Turbines**

Introduction; Classification; Impulse v/s Reaction turbines. Impulse/De Level turbine: Pressure and velocity variation, Compounding of impulse turbines: purpose types; pressure and velocity variation, velocity diagrams/triangles; Combined velocity diagram/triangles and calculations for force, axial thrust, work, power, blade efficiency, stage efficiency, maximum work and maximum efficiency, overall efficiency and relative efficiency, effect of blade friction on velocity diagram, effect of speed ratio on blade efficiency, condition for axial discharge. **(5 hrs)**

6. **Reaction Turbines**

Pressure and velocity variation, velocity diagrams/triangles, Degree of reaction, combined velocity diagram/triangles and calculations for force, axial thrust, work, power, blade efficiency, stage efficiency, overall efficiency and relative efficiency, maximum work and maximum efficiency; Calculations of blade height.Multistaging: Overall efficiency and relative efficiency; Reheating, Reheat factor and condition curve; Losses in steam turbines; Back pressure and extraction Turbines ; Co-generation; Economic assessment; Governing of steam turbines. **(10 hrs)**

7. Steam Condensers

Function; Elements of condensing unit; Types of condensers; Dalton's law of partial pressures applied to the condenser problems; Condenser and vacuum efficiencies; Cooling water calculations; Effect of air leakage; Method to check and prevent air infiltration; Description of air pump and calculation of its capacity. **(5 hrs)**

8. Reciprocating Air Compressors

Single stage single acting reciprocating compressor(*with* and *without clearance volume*): construction, operation, work input and best value of index of compression, heat rejected to cooling medium, isothermal, overall thermal, isentropic, polytropic and mechanical efficiency, Clearance volumetric efficiency, Overall volumetric efficiency, effect of various parameters on volumetric efficiency, free air delivery; Multistage compressors: purpose and advantages, construction and operation, work input, heat rejected in intercoolers, minimum work input, optimum pressure ratio; isothermal, overall thermal, isentropic, polytropic and mechanical efficiencies; Performance curves. **(5 hrs)**

SUGGESTED TEXT/REFERENCE BOOKS:

1. Y. R. Yadav, "Applied Thermodynamics", Central Publishing House , Allahabad
2. P.K.Nag, "Basic & Applied Thermodynamics", Tata McGraw Hill Education Pvt. Ltd.,West Patel Nagar, New Delhi-110 008.
3. Domkundwar, Kothandaraman, Domkundwar, "A Course in Thermal Engineering", Dhanpat Rai & Co.
4. Mahesh M. Rathore; "Thermal Engineering"; Tata McGraw Hill Education Pvt. Ltd.; New Delhi.
5. Onkar Singh; "Applied Thermodynamics"; New Age International Publisher.
6. T.D Eastop and A. McConkey, "Applied Thermodynamics and Engineering" Fifth Edition 2002, Pearson Education India
7. W.A.J. Keartan, Steam Turbine: , "Theory and Practice", ELBS Series

BTME 404C: MACHINE DRAWING

Semester	IV					
Course code	BTME 404C					
Category	Engineering Science Courses (B.Tech. ME)					
Course title	Machine Drawing (Theory & Practical)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	1	0	6	40	60	04

COURSE OBJECTIVES:

The objective of this course is to make students understand the principles and requirements of production drawings and learning how to assemble and disassemble important parts used in major mechanical engineering applications.

COURSE OUTCOMES:

After going through this course, it is expected that the students will be able to understand the drawings of various mechanical components and their assemblies along with their utility for design of components and further will be able to:

1. Read, draw and interpret the machine drawings and related parameters.
2. Learn and utilize the standards used in machine drawings of machine components and assembly drawings.
3. Understanding of limits fits and tolerances applied in various mating machine parts.
4. Draw the different views of a component in the assembly.
5. Use CAD tools for making drawings of machine components and assemblies.

1. **Introduction**: Principles of Drawing. Requirements of production drawing, Sectioning and conventional representation, Dimensioning, symbols of standard tolerances, Machining Symbols, introduction and Familiarization of Code IS: 296 **(10 Hrs)**
2. **Fasteners**: Various types of screw threads, types of nuts and bolts, screwed fasteners, welding joints and riveted joints **(05 Hrs)**
3. **Assembly and Disassembly**

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

(b) Knuckle and cotter joints,

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

(d) IC Engine Parts: Piston, connecting rod

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

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

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

(30 Hrs)

4. Practice using Computer Aided Drafting (CAD) Tools.

(a) Machine components, screw fasteners, Keys cotters and joint, shaft couplings, Pipe joints and fittings, riveted joints and welded Joints.

(b) Assemblies: Bearings (Plumber Block, Footstep, Swivel), boiler mountings, screw jack, Exercise in computer plots of drawing. **(15 Hrs)**

SUGGESTED TEXT/REFERENCE BOOKS:

1. P.S Gill, "Machine Drawing", S K Kataria and sons. 18th edition, 2017 reprint
2. N.D.Bhatt, "Machine Drawing". Charotar publications, 49 edition, 2014
3. Ajeet Singh, "Machine Drawing (including Auto CAD)", Tata McGraw Hill, 2nd edition, 2012
4. G. Pohit, "Machine Drawing with Auto CAD". Pearson Education Asia, 2007.
5. IS code SP 46(2003): Engineering Drawing Practice for schools and colleges by Bureau of Indian Standards

BTME 405C: MANUFACTURING PROCESSES II

Semester	IV					
Course code	BTME 405 C					
Category	Professional Core Course (B.Tech.ME)- Diploma Course					
Course title	Manufacturing Processes II (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

COURSE OBJECTIVES:

To motivate and challenge students to understand and develop an appreciation of the processes in correlation with material properties which change the shape, size and form of the raw materials into the desirable product by conventional or unconventional manufacturing methods.

COURSE OUTCOMES:

After studying this course, students shall be able to:

1. Use machine tools such as lathe, shaper and milling machine for machining/cutting various profiles on work pieces.
2. Learn about the constructional features and working of rolling mills, drawing and extrusion equipment.
3. To understand the construction and working of various press tools, Dies etc
4. Learn about the various unconventional manufacturing methods.

1. **Metal Forming**: Classification, hot and cold working processes, plastic deformation and yield criteria; fundamentals of hot and cold working processes, Types: Rolling, forging, extrusion, drawing, Special forming processes: rotary swaging, ring rolling, gear forming, tandem rolling, thread rolling. Forming defects: Causes and remedial actions.
2. **Metal Cutting**: Single and multi-point cutting; Orthogonal cutting, various force components: Chip formation, Tool wear and tool life, Surface finish and integrity, Machinability, Cutting tool materials, Cutting fluids, Turning, Drilling, Milling and finishing processes.
3. **Sheet Forming** (shearing, deep drawing, bending). Principles of powder metallurgy, various processes & products of powder metallurgy. Advantaged & disadvantages of PM.
4. **Unconventional Machining Processes** : Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ultrasonic Machining, Electrical Discharge Machining, wire EDM; Electro-chemical machining (ECM), Laser Beam Machining (LBM), Plasma

Arc Machining (PAM) and Electron Beam Machining, Introduction , principle and processes parameters, Introduction to CNC machining.

SUGGESTED TEXT/REFERENCE BOOKS:

1. Rao P N, Manufacturing Technology, Foundry, Forming & Welding, TataMcGraw Hill.
2. Kalpakjian S and Steven R.Schmid, Manufacturing Engineering and Technology, Pearson Publishers.
3. Mikell P. Groover, Fundamentals of Modern Manufacturing Materials, Processes, and Systems
4. Ghosh A, & Mallik A K . Manufacturing science:
5. Campbell J S, Principles of manufacturing materials and processes: Tata McGraw-Hill
6. Shan H S, Manufacturing Processes, Vol. I, Pearson Publishers.

BTME406C: APPLIED THERMODYNAMICS LAB

Semester	IV					
Course code	BTME 406C					
Category	Professional Core Course (B.Tech.ME)					
Course title	Applied Thermodynamics Lab (Practical)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	0	0	2	30	20	01

COURSE OBJECTIVES:

This course aims to understand various concepts of Applied Thermodynamics through lab work. The Mechanical Engineering students study sectioned models of various boilers, mountings, accessories, two stroke and four stroke I.C. engines, condensers for better understanding. The conduct of experiments on I.C. engine test rigs and two stage air compressor test rig improve knowledge of performance analysis.

COURSE OUTCOMES:

After studying this course, students shall be able to:

1. Understand the construction and working of IC engines, boilers, mountings, accessories, condensers.
2. Evaluate performance of I.C. engines and two stage compressors.

LIST OF PRACTICALS

1. Study of construction and operation of 2 stroke and 4 stroke Petrol and Diesel engines using actual engines or models.
2. To plot actual valve timing diagram of a 4 stroke petrol and diesel engines and study its impact on the performance of engine.
3. To study construction, working & applications of low pressure boilers with help of the models.
4. To study construction, working & applications of high pressure boilers with help of the models.
5. Study of working, construction, mountings and accessories of various types of boilers.
6. To perform a boiler trial to estimate equivalent evaporation and efficiency of a fire tube/ water tube boiler.
7. Determine the brake power, indicated power, friction power and mechanical efficiency of a multi cylinder petrol engine running at constant speed (Morse Test).
8. Performance testing of a Petrol and Diesel engine from no load to full load (at constant speed) for a single cylinder/ multi- cylinder engine in terms of brake power, indicated power, mechanical efficiency and specific fuel consumption and to measure the exhaust emission. Also make the heat balance sheet.
9. To study of various types of steam condensers with help of the models.
10. To evaluate performance parameters of single/two stage reciprocating compressor

BTME 407C: MANUFACTURING PROCESSES LAB

Semester	IV					
Course code	BTME 407 C					
Category	Professional Core Course (B.Tech.ME)					
Course title	Manufacturing Processes Lab (Practical)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	0	0	2	30	20	01

COURSE OBJECTIVES:

Upon completion of this course, students will be able to understand the different conventional and unconventional manufacturing methods employed for making different products.

LIST OF PRACTICALS

1. To study constructional features of following machines through drawings/ sketches: a. Grinding machines (Surface, Cylindrical) b. Hydraulic Press c. Draw Bench d. Drawing and Extrusion Dies e. Rolling Mills
2. To grind single point and multipoint cutting tools
3. To prepare job on Lathe involving specified tolerances; cutting of V- threads and square threads.
4. To prepare job on shaper involving plane surface,
5. Use of milling machines for generation of plane surfaces, use of end mill cutters.
6. At least one industrial visit must be arranged for the students for the live demonstration of various unconventional manufacturing processes like EDM, ECM, CNC machining etc

5th SEMESTER

BTME 501C: HEAT TRANSFER

Semester	V					
Course code	BTME 501C					
Category	Professional Core Course (B.Tech. ME)					
Course title	Heat Transfer (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	1	0	40	60	04

COURSE OBJECTIVES

This subject has been designed to provide knowledge about application of conduction, convection and radiation heat transfer concepts to different practical applications. The students will also understand the importance of studying the course of mathematics in solving complex engineering problems theoretically with special reference to the problems on heat transfer in various modes.

COURSE OUTCOMES

After successfully completing this course, the students/learners will be able to:

1. Learn different types of modes of heat transfer and their applications, General Heat Conduction Equation and **c**ompute temperature distribution in steady-state and unsteady-state heat conduction.
2. To identify, formulate, and solve engineering problems involving conduction heat transfer through Extended Surfaces. The student will be able to understand the concept of Transient heat conduction.
3. To train students to identify, formulate, and solve engineering problems involving forced convection heat transfer and natural convection heat transfer
4. Demonstrate an ability to analyze the performance of heat exchangers. The student will be able to understand the concept of Boiling and Condensation
5. Learn the fundamental principles, laws of radiation and process of heat flow due to radiation. To train students to identify, formulate, and solve engineering problems involving radiation heat transfer among black surfaces and among diffuse gray surfaces.

1. **Introduction:** Heat Transfer - Different Modes, Governing Laws, Difference between the subject of "Heat Transfer" and its parent subject "Thermodynamics". Applications of Heat Transfer.Fourier's law of heat conduction. Coefficient of thermal conductivity. Effect of temperature and pressure on thermal conductivity of solids, liquids and gases. Numerical Problems
2. **General Heat Conduction Equation**: Derivation of the equation in (i) Cartesian, (ii) Polar and (iii) Spherical Coordinate Systems.
3. **Steady State one-dimensional Heat conduction:** Deduction of one-dimensional steady state heat conduction equation in rectangular; cylindrical and spherical coordinates with and without internal heat generation for uniform thermal conductivity of material. Concept of variable thermal conductivity. Electrical network analysis for heat transfer through composite/multilayer material. Application of heat conduction with internal heat generation in case of piston crown and in nuclear fuel rod with/ without cladding. Concept of

equivalent area. Conduction shape factor. Conduction through edges and corners of walls. Critical thickness of insulation layers on electric wires and pipes carrying hot fluids.

4. **Extended Surfaces or Fins:** Classification, Straight Rectangular and Circular Fins, Temperature Distribution and Heat Transfer Calculations, Fin Efficiency and Effectiveness, Applications, Numerical Problems.
5. **Transient/Unsteady-state heat conduction:** Definition, Different cases - Negligible internal thermal resistance, negligible surface resistance, comparable internal thermal and surface resistance, Lumped body, Infinite Body and Semi-infinite Body, Numerical Problems, Heisler and Grober charts: Solutions to various one-dimensional problems using the charts, Numerical problems.
6. **Forced Convection:** Boundary Layer Theory, Velocity and Thermal Boundary Layers, Prandtl number, Governing Equations - Continuity, Navier-Stokes and Energy equations, Boundary layer assumptions, Integral and Analytical solutions to above equations, Turbulent flow, Various empirical solutions, Numerical Problems, Forced convection flow over cylinders and spheres, Internal flows -laminar and turbulent flow solutions, Numerical Problems.
7. **Natural Convection:** Physical mechanism of natural convection. Buoyant force. Empirical heat transfer relations for natural convection over vertical planes and cylinders, horizontal plates and cylinders, and sphere. Combined free and forced convection.
8. **Heat Exchangers:** Definition, Classification, LMTD method, Effectiveness - NTU method, Analytical Methods, Numerical Problems, Chart Solution for Heat Exchanger Problems: Correction Factor Charts and Effectiveness-NTU Charts, Numerical Problems.
9. **Boiling and Condensation:** Boiling: Definition and types of boiling. Different regimes and heat transfer during pool boiling of a liquid. Nucleation and different theories accounting for increased heat transfer coefficient during nucleate phase of boiling. Condensation: Definition and types of condensation, film wise condensation on a vertical and inclined surface.
10. **Thermal Radiation:** Fundamental principles - Gray, White, Opaque, Transparent and Black bodies, Process of heat flow due to radiation. Definition of emissivity, absorptivity, reflectivity and transmissivity. Spectral emissive power, Wien's, Rayleigh-Jeans' and Planck's laws, Lambert's Cosine law. Definition of intensity of Radiation, irradiation and radiosity.Hemispherical Emissive Power, Stefan-Boltzmann law for the total emissive power of a black body, Emissivity and Kirchhoff's Laws, View factor, View factor algebra, Net radiation exchange in a two-body enclosure, Typical examples for multi-body enclosures, Radiation Shield, Numerical problems.

SUGGESTED TEXT/REFERENCE BOOKS:

1. Incropera, F. P. and De Witt, D. P., Fundamentals of Heat and Mass Transfer, John Wiley and Sons, New York, 8th edition, 2019.
2. Holman, J. P., Bhattacharyya Souvik, Heat Transfer, Tata McGraw Hill, New Delhi, 10thm Edition 2017.
3. Kumar, D.S. "Fundamentals of Heat and Mass Transfer", S K Kataria& Sons, 7th Edition, 2013.

4. Cengel, A. Yunus, "Heat and Mass Transfer", Tata McGraw Hills Education Private Ltd, 4 th Edition, 2013.
5. M. Necati Ozisik, Heat Transfer- A Basic Approach , McGraw Hill, New York., 1985
6. Alan J. Chapman, Macmillan, Heat Transfer, New York, 4th edition, 2016.
7. Chapman. A. J, "Heat Transfer", McGraw Hill, 7th Edition, 1990.

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BTME502C: DESIGN OF MACHINE ELEMENTS

Semester	V					
Course code	BTME 502C					
Category	Professional Core Course (B.Tech. ME)					
Course title	Design of Machine Elements (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	1	0	40	60	04

COURSE OBJECTIVES

To provide knowledge of design procedure for simple components like keys, cotters, fasteners, shafts, couplings, pipe joints and levers under static and fatigue loading. Objective of this course is to make the students capable of designing mechanical systems consisting of wide range of machine elements.

COURSE OUTCOMES

After successfully completing this course, the students/learners will be able to:

1. Demonstrate recalling and applying knowledge of Basic Sciences, Graphics & Drawing, Basic Manufacturing Processes and Material Science, for design procedures of various Mechanical components.
2. Comprehend the effect of different stresses and strains under various loading conditions on the mechanical components and identify the mechanism/mode of failure.
3. Examine and solve design problems involving machine elements on the basis of various theories of failure.
4. Synergize forces, moments and strength information to develop ability to analyze, design and/or select machine elements aiming for safety, reliability, and sustainability.

1. Introduction

Meaning of design with special reference to machine design, general design considerations, concept of tearing, bearing, shearing, crushing, bending and fracture. **3Hrs**

2. Design of Shaft

Design of shafts under static and fatigue loadings, Design of solid and hollow shafts for transmission of torque, bending moments and axial forces, Design of shaft for rigidity.

3Hrs

3. Design of Bearings

Slider: Principle of hydrodynamic lubrication, modes of lubrication, bearing performance parameters, slider bearing design. Roller: Types, selection guidelines, static and dynamic load carrying capacity, Stribeck's equation, equivalent bearing load, load life relationship.

4Hrs

4. Design of Transmission Drives

Belt drives: Design of Flat belt, V-belt, Design of the pulley for the same. Selection of belts from the manufacturer's catalogue. Chain Drives: Design of roller chains, polygonal effect, power rating. Gear drives: Standard system of gear tooth and gear module, gear tooth failure, strength of gear tooth, terminology of spur, helical, bevel, worm and worm wheel, Design of spur, helical, straight bevel gears, worm and worm wheel. **9Hrs**

5. Design of springs

Design of springs: helical compression, tension, torsional and leaf springs. **4Hrs**

6. 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. **4Hrs**

7. Design of bolts

Bolts: Understanding the various stresses/failure in bolted joints, design of cylindrical covers under basic loaded bolts.

Welds: Design for various loading conditions in torsion, shear or direct load. **4Hrs**

8. Design of Keys and Couplings

Design of sunk keys under crushing and shearing, design of splines, design of sleeve and solid muff coupling, clamp or compression coupling, rigid and flexible flange coupling **5Hrs**

SUGGESTED TEXT/REFERENCE BOOKS

1. Joseph E. Shigley, Charles Russell Mischke, Richard Gordon Budynas, Mechanical Engineering Design, McGraw-Hill
2. Robert L. Norton, Machine Design; An Integrating Approach, Pearson Publication
3. Robert C. Juvinall Fundamentals of machine component design, John Wiley Eastern
4. V.B Bhandari, Design of Machine elements, Tata Mc-Graw. Hill
5. Machine Design by R.S. Khurmi & J K Gupta

Note: Design Data book is allowed in Examination

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BTME 503C: ENGINEERING MATERIALS AND METALLURGY

Semester	V					
Course code	BTME 503C					
Category	Professional Core Course (B.Tech. ME)					
Course title	Engineering Materials and Metallurgy (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

COURSE OBJECTIVE

This course is designed to develop fundamental concepts of crystallography, phase transformation and heat treatment processes. The student will also be able to learn about phase diagrams and heat treatment various processes and their use for control of structure of steel.

COURSE OUTCOMES

After successfully completing this course, the students/learners will be able to:

1. Learn the atomic structure of metals, imperfections, diffusion mechanisms and theories of plastic deformation.
2. Understand equilibrium diagrams, time-temperature transformation curves and heat treatment processes.
3. Understand the concepts of crystal structure, microstructure and deformation.
4. Understand the phase diagrams and their use
5. Alloying elements and their effect on structure and properties of steel

1. **Crystallography**: Atomic structure of metals, atomic bonding in solids, crystal structures, crystal lattice of body centered cubic, face centered cubic, closed packed hexagonal; crystalline and non-crystalline materials; crystallographic notation of atomic planes; polymorphism and allotropy; imperfection in solids: theoretical yield strength, point defects, line defects and dislocations, interfacial defects, bulk or volume defects. Diffusion: diffusion mechanisms, steady-state and non steady-state diffusion, factors affecting diffusion. Theories of plastic deformation, recovery re-crystallization. **12 Hrs**
2. **Phase Transformation**: General principles of phase transformation in alloys, phase rule and equilibrium diagrams, Equilibrium diagrams of Binary systems. Iron carbon equilibrium diagram and various phase transformations. Time temperature transformation curves (TTT curves): fundamentals, construction and applications. **09 Hrs**
3. **Heat Treatment:** Principles and applications. Processes viz. annealing, normalizing, hardening, tempering. Surface hardening of steels: Principles of induction and oxyacetylene flame hardening. Procedure for carburizing, nitriding and cyaniding. Harden-ability: determination of harden-ability.Jominy end-quench test. Defects due to heat treatment and their remedies; effects produced by alloying elements. Composition of alloy steels. **09 Hrs**
4. **Ferrous Metals and Their Alloys:** Introduction, classification, composition of alloys, effect of alloying elements (Si, Mn, Ni, Cr, Mo, W, Al) on the structures and properties of steel. **06 Hrs**

SUGGESTED TEXT BOOKS

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

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BTME 504 C: AUTOMOBLIE ENGINEERING

Semester	V					
Course code	BTME 504 C					
Category	Advance Diploma Course -1 (B.Tech. ME)					
Course title	Automobile Engineering (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

COURSE OBJECTIVES

This course aims to provide knowledge to engineering students to to understand the construction and working principle of various parts of an automobile. The student will also have understand ing of the practices used for assembling and dismantling of engine parts and transmission systems.

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Identify the different parts of the automobile.
2. Explain the working of various parts like engine, transmission, clutch, brakes, steering and the suspension systems.
3. Understand fuel supply system and use of lubricants
4. Develop a strong base for understanding vehicle safety systems and future developments in the automobile industry.

1. **Introduction:** Basic structure, general layout and type of automotive vehicles, Frameless and unitary construction; position of power unit.
2. **Power Unit:** Power requirements - motion resistance and power loss, tractive effort and vehicle performance curves; selection of power unit and engine performance characteristics; pollution due to vehicle emission and exhaust emission control system, turbo chargers (WGT, VGT), engine emission control by 3-way catalytic converter system, Emission norms (Euro & BS).
3. **Fuel Supply System:** Air cleaner and fuel pumps; Air fuel requirements and carburation; constructional details of fuel injection systems (MPFI) used in Indian make vehicles. Diesel fuel system (IDI, DI & CRDI) - cleaning, injection pump, injector and nozzles. Introduction to Gasoline Direct Injection and duel fuel supply systems.
4. **Lubrication and Cooling Systems:** Necessity of lubrication; Desirable properties of lubricants; various types of lubricants and oil additives; different systems of lubrication - oil filters, oil pumps and oil pressure indicator; crank case ventilation and dilution. Purpose of cooling, air and water cooling systems; radiator, thermostat, pump and fan.
5. **Chassis and Suspension:** Loads on the frame, considerations of strength and stiffness, engine mounting, conventional and independent suspension systems; adaptive suspension systems; shock absorbs and stablizers; wheels and tyres.
6. **Transmission system:** Basic requirements and components of transmission systems; constructional features of automobile clutch, gear boxes & types, differential, front and rear axles; overdrives, propeller shaft, universal joint and torque tube drive; Rear wheel vs front wheel drive, principle of automatic transmission. Types of automatic transmissions (Torque convertor AT, AMT, CVT, DCT/DSG). Traction control system.
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 balancing & alignment; power steering (electrical and hydraulic).

8. **Braking System:** General braking requirements; Weight transfer during braking and stopping distances; Mechanical, hydraulic, vacuum power and servo brakes; Adaptive cruise control and braking system
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
10. **Vehicle safety systems:** Active and passive safety systems in an automobile. Air bags, collapsible steering system, seat belts, side impact rods, crumple zones etc. ABS & EBD, ESP, diver alert system.
11. **Alternative Energy Sources:** Concept and types of electric & Hybrid Vehicles. Fuel cell technology, Use of Natural Gas, Liquefied Petroleum Gas, Bio-diesel, Bio-ethanol, Gasohol and Hydrogen in Automobiles- Engine modifications required -Performance,
12. **Maintenance:** Preventive maintenance, trouble shooting and rectification in different systems; engine turning and servicing

RECOMMENDED TEXT/REFRENCE BOOKS

1. W.H Crouse, Automotive mechanics, McGraw Hill
2. J. Heitner, Automotive Mechanics, East West Press
3. Kirpal Singh, Automobile Engineering Vol. I and II, Standard Publishers
4. J. Webster, Auto Mechanics, Glencoe Publishing Co.
5. P.S Gill, Automobile Engineering, S.K Kataria

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BTME 505C: HEAT TRANSFER LAB

Semester	V					
Course code	BTME 505C					
Category	Professional Core Course (B.Tech. ME)					
Course title	Heat Transfer Lab (Practical)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	0	0	2	30	20	01

COURSE OUTCOMES

After successfully completing this course, the students/learners will be able to:

1. To make students understand of experimental procedure to solve heat transfer problems by selecting some physical situations pertaining to different modes of heat transfer.
2. To make students understand the measurement procedure for monitoring the physical parameters like temperature, flow velocity and energy.
3. To make students understand the experimental data analysis and the errors involved in experimental measurements and discuss the correct measurement techniques to acquire most reliable information.
4. To teach students the correct way to write the report based on experimental observations

LIST OF PRACTICALS

1. To study and compare temperature distribution, heat transfer rate, overall heat transfer inparallel flow and counter flow heat exchanger.
2. To study the heat transfer through Composite Slab Apparatus – Overall heat transfer co-efficient.
3. To find the thermal conductivity using two slab guarded hot plate method.
4. To study the heat transfer through a Concentric Sphere
5. To determine thermal conductivity of given metal rod.
6. To determine heat transfer coefficient in natural convection.
7. To determine heat transfer coefficient in forced convection for air flowing in a tube.
8. To determine heat transfer coefficient in drop wise and film wise condensation.
9. To determine the emissivity of a given plate at different temperatures.
10. To determine heat transfer through lagged pipe.
11. To determine heat transfer in pin-fin.
12. To conduct experiment on Transient Heat Conduction.
13. To study of heat pipe and its demonstration.

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BTME 506C: AUTOMOBLIE ENGINEERING LAB

Semester	V					
Course code	BTME 506C					
Category	Advance Diploma Course -1 (B.Tech. ME)					
Course title	Automobile Engineering Lab (Practical)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	0	0	2	30	20	01

COURSE OUTCOMES:

After successfully completing this course, the students/learners will be able to:

1. Identify Construction, working, preventive maintenance, trouble shooting and diagnosis of various Automobile Systems.
2. Understand importance and features of different systems like axle, differential, brakes, steering,
   suspension, and balancing etc.
3. Identify Modern technology and safety measures used in Automotive Vehicles

LIST OF PRACTICALS

1. Valve refacing and valve seat grinding and checking for leakage of valves
2. Trouble shooting in cooling system of an automotive vehicle
3. Trouble shooting in the ignition system, setting of contact breaker points and spark plug gap

4. Demonstration of steering system and measurement of steering geometry angles and their impact on vehicle performance.
5. Trouble shooting in braking system with specific reference to master cylinder, brake shoes, overhauling of system and the adjusting of the system and its testing.
6. Fault diagnosis in transmission system including clutches, gear box assembly and differential.
7. Replacing of ring and studying the method of replacing piston after repair.
8. Dismantling and assembling of diesel and petrol engine.
9. Study of cut section model of Petrol and diesel engine.

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BTME 507C: ENGINEERING MATERIALS AND METALLURGY LAB

Semester	V					
Course code	BTME 507C					
Category	Professional Core Course (B.Tech. ME)					
Course title	Engineering Materials and Metallurgy Lab (Practical)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	0	0	2	30	20	01

LIST OF PRACTICALS

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

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DEPARTMENT ELECTIVE SUBJECTS

(5th SEMESTER)

BTME 511 C: INTERNAL COMBUSTION ENGINES

Semester	V					
Course code	BTME 511 C					
Category	Departmental Elective - I (B.Tech)					
Course title	Internal Combustion Engines (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

COURSE OBJECTIVES

This subject has been designed for students:

1. To understand the construction and working principle of various parts of an IC engines.
2. To learn about various Fuel Metering systems in SI and CI Engines.
3. To understand the combustion phenomenon in IC engines.
4. To learn about the harmful and pollutant emissions from IC Engines.
5. To learn about the various devices used for the measurement and testing of IC engines.

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Learn different types of internal combustion engines and their applications, analyze thermodynamic cycles, and demonstrate a basic understanding of engine function, working of IC Engines.
2. Understand the Fuel Metering system in SI and CI Engines, IC engines fuels and analyze the air-fuel mixture requirements for combustion of fuel.
3. Learn to the combustion phenomenon in SI and CI Engines, Stages of Combustion, ignition lag, combustion chambers for IC engines, types of superchargers and their analysis.
4. Ability to ascertain the effects of fuel/supply systems on emission from an engine, Identify harmful IC engine-out emissions and the viable alternate fuels.
5. Determine and understand the performance of internal combustion engine.

1. **Introduction to IC Engines:** Heat Engine versus Internal Combustion Engine, Historical development of IC Engines, Classification and Nomenclature, Applications of IC Engines. Review of Air standard cycles: Carnot, Sterling, Ericsson, Otto, Diesel and Dual Cycle etc.
2. **Working of IC Engines:** Working of 4 stroke SI and CI Engines and their valve timing diagram, working of 2-stroke SI and CI engines and their valve timing diagrams, Comparison of two stroke and four stroke Engines, Fuel Air Cycles and their analysis: Composition of cylinder gases, variable specific heats, Dissociation, Effect of number of moles, Air standard versus fuel air cycles, Effect of operating variables like compression ratio, fuel air ratio. Actual engine cycles and losses: Comparison between Actual, Fuel- Air cycle, Air standard cycles for S.I. and C.I engines.
3. **IC Engine Fuels:** Requirements of fuel in I C engines, Type of Fuels- Solid, Liquid and Gaseous fuels, Important qualities of SI and CI engine fuels and their ratings. Combustion of Fuels: Heating values of Fuels, Theoretical determination of heat of reactions of fuel, Combustion equation for Hydrocarbon fuels, Determination of minimum air required for combustion, conversion of volumetric analysis to mass analysis, Determination of air

supplied from volumetric analysis of Dry flue gases, Determination of excess air supplied, Determination of percentage of carbon from exhaust gas composition

4. **Air-Fuel Mixture Preparation Systems:** Fuel supply system and fuel pumps, Simple carburetor and its working, approximate analysis of single jet carburetor, Actual Air fuel calculation of single jet carburetor, Ideal requirements from an ideal carburetor, limitations of single jet carburetor, Different devices used to meet the requirements of an ideal carburetor, Different modern carburetors, Petrol injection. Fuel Injection systems for CI Engines: Classification of Injection Systems, Injection Pump, Fuel Injector, Nozzle, and Injection in SI Engines.
5. **Combustion in SI Engine:** Stages of Combustion in S I Engine, flame front propagation, factors influencing the flame speed, ignition lag and factors affecting the ignition lag, Abnormal combustion and knocking, control and measurement of knock, Anti knock agents, combustion chambers of S I engines.
6. **Combustion in CI Engines:** Stages of combustion, Delay period, factors affecting delay period; detonation and factors affecting detonation; comparison of abnormal combustion in SI & CI engine, rating of IC engine fuels, combustion chambers for IC engines.
7. **Supercharging:** Purpose of supercharging, types of superchargers. Analysis of superchargers. Arrangement of supercharger and its installation, turbo charged engines, supercharging of SI & CI engines, limitations of supercharging.
8. **Pollutant emissions from IC Engines:** Introduction to clean air, Pollutants from SI and CI Engines: Carbon monoxide, UBHCs, Oxides of nitrogen (NO-NOX) and Particulate Matter. Mechanism of formation of pollutants, Factors affecting pollutant formation. Brief treatment on Measurement of engine emissions-instrumentation and pollution Control Strategies, Emission norms-EURO and Bharat stage norms.
9. **Measurement and Testing:** Measurement of Friction Power, Brake Power, indicated Power, Measurement of Speed, Air consumption, fuel consumption, heat Balance Sheet for engine, governing of IC Engines. Performance Characteristics of IC Engines: Performance parameters, performance of SI engines, performance of C.I. engines, Engine performance maps.

RECOMMENDED BOOKS

1. Heywood J B, “Internal Combustion Engine Fundamentals”, McGraw Hill, Publication, New Delhi (1988).
2. Taylor C F, “The Internal Combustion in Theory and Practice”, Volume I and II, MIT Press, Cambridge, Mass (1968).
3. PulkRabek W W, “Engineering Fundamentals of Internal Combustion Engine”, Pearson Education, New Delhi (2003).
4. Stone R, “Introduction to Internal Combustion Engines”, 2nd Edition, Macmillan (1993).
5. Milton B E, “Thermodynamics, Combustion and Engines”, Champman and Hall (1995).
6. R. Yadav, “Applied Thermodynamics”, Central Publishing House, Allahabad.

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BTME 512C: MAINTENANCE AND RELIABILITY

Semester	V					
Course code	BTME 512 C					
Category	Departmental Elective -I (B.Tech)					
Course title	Maintenance and Reliability (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

COURSE OBJECTIVE

This course is designed to introduce basic concepts of maintenance and reliability to the students, to introduce various method of reliability analysis with real time problems with constraints and to make understanding the applications of Reliability and maintenance analysis for different types of systems.

COURSE OUTCOMES

1. Understand the concepts of reliability and maintainability.
2. The students will be able to use statistical tools to characterize the reliability of an item and determine the reliability of a system.
3. The students will also understand the application of maintenance strategies in a manufacturing environment.
4. The students will develop ability in formulating suitable maintenance strategies to enhance system reliability of a manufacturing system.

1. **Introduction**
   Objective and characteristics of maintenance function, Organization of the maintenance system, Operating practices in maintenance, Maintenance record keeping. **(4 hrs)**
2. **Cost Aspect of Maintenance**
   Costs of machine breakdown, estimation of life cycle costs, Application of work measurement in maintenance, Manpower planning and training, Incentive payments for maintenance. **(7 hrs)**
3. **Planning of Maintenance Activities**
   Evaluation of alternative maintenance policies breakdown, preventive and predictive maintenance, fault diagnosis and condition monitoring techniques, simulation of alternative practices, Development of preventive maintenance schedule, Housekeeping practices, total productive maintenance. **(5 hrs)**
4. **Maintenance Engineering**
   Maintenance requirements of mechanical, electrical, process and service equipment, Safety aspect in maintenance, Aspect of lubrication; chemical control of corrosion, Computerized maintenance information systems. **(5 hrs)**
5. **Reliability**
   Concept and definition, configuration of failure data, various terms used in failure data analysis in mathematical forms, component and system failures, uses of reliability concepts in design and maintenance of different system. **(5 hrs)**

6. **Reliability and Availability of Engineering systems**
   Quantitative estimation of reliability of parts, Reliability of parallel and series elements, Accuracy and confidence of reliability estimation, Statistical estimation of reliability indices, Machine failure pattern, Breakdown time distribution. **(4 hrs)**
7. **Reliability improvement**
   Reliability in design, reliability in engineering, systems, systems with spares, reliability simulation, redundant and stand by systems, confidence levels, component improvement element, unit and standby redundancy optimization and reliability-cost trade off. **(3 hrs)**
8. **Fault Tree Analysis**
   Introduction and importance, fault tree construction, reliability calculations from fault tree, tie set and cut set methods, event tree and numerical problems. **(3 hrs)**

RECOMMENDED BOOKS

1. Lindley R. Higgins, "Maintenance Engineering Handbook", McGraw Hill.
2. R.H. Clifton, "Principles of Planned Maintenance", Edward Arnold.
3. A Kelly, "Maintenance Planning control", McGraw Hill.
4. L.S Srinath, "Reliability Engineering", East West Press.
5. S.K. Sinha, "Reliability Engineering", John Wiley
6. Ebling CE,"An introduction to Reliability and Maintainability Engineering",Tata McGraw Hill, Delhi, 2004.
7. Dhillon B S, "Engineering Maintainability", Prentice Hall of India, New Delhi, 2000.
8. Wireman Terry, "Preventive Maintenance", Reston Publishing Company, Reston Virginia, 1998.

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BTME 513C: OPERATIONS RESEARCH

Semester	V					
Course code	BTME 513C					
Category	Departmental Elective-I (B.Tech)					
Course title	Operations Research (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

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.

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.

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 hrs)**
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 hrs)**
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 hrs)**
4. **Simulation:** Concept general approach and application. Use of Monte-Carlo simulation technique to queuing and inventory problems**.** **(3 hrs)**
5. **Dynamic Programming:** Introduction to deterministic and probabilistic dynamic programming. Solution of simple problems. **(3 hrs)**
6. **Queuing Theory:** Types of queuing situation: Queuing models with Poisson's input and exponential service, their application to simple situations. (**4 hrs**)
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 hrs)**
8. **Inventory Models:** Inventory models: Classification of inventory control models: Inventory models with deterministic demand, inventory models with probabilistic demand, and inventory models with price breaks**.** **(4 hrs**)
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 hrs)**

RECOMMENDED 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

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BTME 514 C: PLANT LAYOUT & MATERIAL HANDLING

Semester	V					
Course code	BTME 514 C					
Category	Departmental Elective-I (B.Tech)					
Course title	Plant Layout &Material Handling (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

COURSE OUTCOMES

After successful completion of this course the students will have:

1. Adequate knowledge for running an organization

2. Understand the integration of material handling systems.

UNIT -I

Influence of location on plant layout, selection of plant site, Consideration in facilities planning and layout. Equipments required for plant operation, Capacity, serviceability and flexibility and analysis in selection of equipments, space requirements, and man power requirements. **(7 Hrs)**

UNIT –II

Need for layout, types of layout, factors influencing product, process. Fixed and combination layout: tools and techniques for developing layout, process chart, flow diagram, string diagram, template and scale models – machine data. Layout planning procedure. Visualization of layout, revision and improving existing layout, balancing of fabrication and assembly lines. **(8 Hrs)**

UNIT –III

Importance and scope. Principles of material handling. Planning, operating and costing Principles, types of material handling systems, factors influencing their choice. **(6 Hrs)**

UNIT –IV

Centralized electrical, pneumatic water line systems. Types of buildings, lighting, heating, air conditioning and ventilation utilities - planning and maintenance, waste handling, statutory requirements. Packing and storage materials: Importance of Packaging, layout for Packaging – Packaging machinery – wrapping and Packing materials, cushion materials. **(9 Hrs)**

UNIT –V

Motion analysis, flow analysis, graphic analysis, safety analysis, equipment cost analysis, palletization analysis, analysis of operation, material handling surveys. **(6 Hrs)**

RECOMMENDED TEXT/REFRENCE BOOKS

1. S. C. Sharma, Plant layout and material handling, Khanna publishers.
2. Agarwal, Plant layout and material handling, Jain brothers publication.
3. Shubin J A, Plant layout, P H I publications.1965
4. Oberman. Ya, Material handling, Mir publishers.1980
5. S.C. Sharma, Material Management And Material Handling, Khanna Publishers.1995

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BTME 515 C: ENERGY CONSERVATION AND MANAGEMENT

Semester	V					
Course code	BTME 515 C					
Category	Departmental Elective- I (B.Tech)					
Course title	Energy Conservation and Management (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

UNIT-I

Introduction to energy & power scenario of world, National Energy consumption data, environmental aspects associated with energy utilization; Energy Auditing- need, types, methodology and barriers, role of energy managers, instruments of energy auditing.

UNIT-II

Components of Electricity Billing. High Tension (HT) and Low Tension (LT) supply, transformers, cable sizing; Concept of capacitors, power factor improvement, harmonics; Electric motors- motor efficiency computation, energy efficient motors; Illumination- Lux, Lumens, types of lighting, efficacy, LED lighting and scope of energy conservation in lighting.

UNIT-III

Thermal systems, Boilers, Furnaces and Thermic Fluid heaters- efficiency computation and energy conservation measures; Steam distribution and usage, steam traps, condensate recovery, flash steam utilization; Insulation & Refractories.

UNIT-IV

Energy conservation in major utilities; pumps, fans, blowers, compressed air systems, Refrigeration& Air Conditioning systems, Cooling Towers, DG sets. Energy Economics- discount period, payback period, internal rate of return, net present value; Life Cycle costing- ESCO concept.

RECOMMENDED BOOKS

1. Witte L.C., Schmidt P.S. and Brown D.R., Industrial Energy Management and Utilization, Hemisphere Publ., Washington
2. Callaghn P.W., Design and Management for Energy Conservation, Pergamon Press, Oxford
3. Murphy W.R. and McKay G., Energy Management, Butterworths, London
4. Energy Manager Training Manual, Bureau of Energy Efficiency (BEE) under Ministry of Power, GOI (available at www.energymanager training.com).

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BTME 516 C: NUMERICAL METHODS IN ENGINEERING

Semester	V					
Course code	BTME 516 C					
Category	Departmental Elective-I (B.Tech)					
Course title	Numerical Methods in Engineering (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

COURSE OBJECTIVES

This course aims to provide knowledge to engineering students to introduce the fundamentals of numerical methods used for the solution of engineering problems to understand the numerical methods and their applicability to problems of engineering. This course will also improve the computer skills of the students.

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Explain fundamental of various numerical methods.
2. Explain various numerical methods for performing tasks, such as interpolation, differentiation, integration, solution of linear and nonlinear equations, solution of differential and integral equations
3. Explain numerical methods to obtain approximate solutions to mathematical problems and evaluate accuracy of various numerical methods and their applicability.
4. Obtain numerical solutions to problems of engineering

1. **Errors in Numerical Calculations**
   Errors in numerical calculations, Error Analysis: Exact and approximate numbers, rounding off numbers, types of errors encountered in computations, general error formulae, approximations of functions and series, propagation of errors. **(3 hrs)**
2. **Solution of Algebraic and Transcendental Equations**
   Bisection method, Regula-falsi method, fixed-point iteration, Newton-Raphson method. Solution of systems of non linear equations. **(3 hrs)**
3. **Interpolation Methods**
   Errors in polynomial interpretation, finite difference, forward, backward and central difference, Difference of a polynomial, Newton's formulae for interpolation, central difference interpolation formulae, Interpolation with unevenly spaced points, Newton's general interpolation formula, and interpolation by iteration. **(5 hrs)**
4. **Curve Fitting**
   Cubic splines and approximation: Introduction, Least square curve fitting, Procedures of fitting a straight line, non linear curve fitting, curve fitting by a sum of exponentials, Data fitting with cubic splines-derivation of governing equation, end conditions. **(5hrs)**
5. **Numerical Differentiation and Integration**
   Introduction, Numerical Differentiation, Numerical Integration, Numerical differentiation-cubic spline method: maximum and minimum values of a tabulated function; Numerical Integration- trapezoidal rule, Simpson1/3 rule, Simpsons 3/8 rule, Newton-cots integration formulae; Euler-Meclaurin formula, Gaussian integration(One dimensional only). **(5hrs)**
6. **Matrices and Linear systems of equations**
   Introduction, Inverse of Matrix, Solution of linear systems, Matrix inversion method, Gaussian Elimination method (fall and banded symmetric and un-symmetric systems),Eigen value problems. . **(5hrs)**

7. **Numerical solution of ordinary differential equations**
   Solution by Taylor's series, Prediction -correction method, Boundary value problems, Prediction corrector method, Euler's and modified Euler's method, Runge-Kutta method, finite difference methods. **(5hrs)**

8. **Numerical solution of Partial differential equations**
   Finite difference approximation to derivatives, Solution to Laplace's equation- Jacobi's method, Gauss -Siedel method, S.O.R method, Parabolic equation and their solution using iterative methods. **(5hrs)**

RECOMMENDED BOOKS:

1. Niyogi, Pradip, "Numerical Analysis and Algorithms", Tata McGraw –Hill
2. Balagurusamy,E., "Numerical Methods", Tata McGraw –Hill
3. Sastry, S.S., "Introduction Methods of Numerical Analysis", PHI
4. Chapra, S.C. and Canale, R.P., "Numerical Methods for Engineers", Tata McGraw –Hill

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6th SEMESTER

BTME601C: REFRIGERATION & AIR CONDITIONING

Semester	VI					
Course code	BTME 601C					
Category	Professional Core Courses (B.Tech. ME)					
Course title	Refrigeration & Air Conditioning (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	1	0	40	60	04

COURSE OBJECTIVES

This course aims to provide knowledge to mechanical engineering students to understand the basic refrigeration cycles of various refrigeration systems, air conditioning systems for different climatic seasons and design aspects of RAC components such as evaporators, condensers, capillary tubes, expansion valve etc.

COURSE OUTCOMES

After successful completion of this course the students will have:

1. To review thermodynamics and thermal systems engineering and develop understanding of vapor compression and heat-driven refrigeration systems.
2. To understand the components of vapour compression refrigeration system.
3. To develop familiarity with refrigerants from the performance and environment point of view.
4. To develop understanding of the principles and practice of thermal comfort.
5. To apply the basic principles of Psychometry and applied Psychometry.
6. To develop an ability for designing the whole system consisting of several components and subsystems.

1. **Basic Concept**
   Natural and Mechanical Refrigeration, Application of refrigeration, Units of refrigeration and Coefficient of performance, Refrigeration effect, cooling capacity and COP of a refrigerator, heating effect, heating capacity and COP as heat pump. **(4 hrs)**
2. **Bell Coleman Cycle and Aircraft Refrigeration**
   Bell Coleman Cycle and its analysis; optimum COP and pressure ratio, necessity of air craft refrigeration – air cycle refrigeration systems and their comparison. **(4 hrs)**
3. **Vapour Compression Refrigeration Cycle**
   Vapour compression cycle on P-V, P-H and T-S diagrams, deviation of actual cycle from theoretical cycle, compressor capacity and volumetric efficiency, analysis of theoretical and actual vapour compression cycles, effect of suction pressure, discharge pressure, sub-cooling, super heating and pressure drop in valves on performance and cooling capacity. **(8 hrs)**
4. **Vapour Absorption Refrigeration Cycle**
   (No Mathematical Analysis) Principle of absorption system; components of the system, Desirable properties of absorption system refrigerant and absorbent, Aqua–ammonia absorption refrigeration system, Lithium Bromide–water absorption refrigeration system; Electrolux refrigeration system, Comparison between absorption and compression system. **(5 hrs)**
5. **Refrigerants**
   Classification and nomenclature of refrigerants, Desirable thermodynamic, chemical and physical properties of refrigerants, comparative study of commonly used refrigerants and their fields of application; Azeotropes, Effect of moisture and oil miscibility, Refrigerant drying

agents and antifreeze solution, leak detection and charging of refrigerants, environmental, aspects of conventional refrigerants, friendly refrigerants. **(5hrs)**

6. **Non-Conventional Refrigeration Systems (No Mathematical Analysis)**
   Cascade Refrigeration System, Linde and Claude cycles for liquefaction of gases. Steam Jet Refrigeration; Vortex Tube Refrigeration,Thermoelectric refrigeration; Liquefaction of gases, cryogenics and its engineering applications. **(5hrs)**
7. **Air Conditioning**
   Concept and Applications, Psychometric properties of air, Dry bulb, wet bulb and dew point temperatures; Relatives and specific humidity; degree of saturation, adiabatic saturation temperature, enthalpy of air and water vapours, psychometric chart. Human requirements of comforts, effective temperature and comfort charts, Industrial and comfort air conditioning. **(5 hrs)**
8. **Psychometric Process**
   Sensible heating and cooling, cooling with dehumidification, Heating with dehumidification, by-pass factor, chemical dehumidification, adiabatic mixing, air washer. Cooling and heating load estimation. **(7hrs)**
9. **Refrigeration and Air Conditioning Equipment**
   Brief description of compressors, condensers and evaporators and expansion devices, Cooling towers. **(5hrs)**

SUGGESTED TEXT/REFERENCE BOOKS:

1. Arora C P, “Refrigeration and Air Conditioning”, 19th Edition, Tata McGraw Hill, Delhi (1985).
2. Pradad M, “Refrigeration and Air Conditioning”, 2nd Edition, New Age International Private Limited, Delhi (2002).
3. Dossat, R J, “Principles of Refrigeration”, 4th Edition, Pearson Education (Singapore), India, (2002).
4. Mcquiston F G, Parker J D and Spilter J D, “Heating, Ventilating, and Air Conditioning”, 5th Edition, John Wiley and Sons Inc, New York (2001).
5. Jordan and Priester, “Refrigeration and Air Conditioning”, Prentice Hall of India (1998).
6. Ananthanarayan, “Basic Refrigeration and Air Conditioning”,3rd Edition, Tata McGraw Hill.
7. Arora & Domkundwar, “Refrigeration and Air conditioning“, DhanpatRai.

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BTME 602C: FLUID MACHINERY

Semester	VI					
Course code	BTME 602C					
Category	Professional Core Course (B.Tech. ME)					
Course title	Fluid Machinery (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

COURSE OBJECTIVES

This course has been designed to understand the main components, constructional and design aspects of hydraulic machines used in hydropower plants. The students will be able to perform the analysis of the energy conversions in different hydraulic machines viz. turbines and pumps to study their performance.

COURSE OUTCOMES

After successful completion of this course the students will have:

1. Basic understanding about various components of hydropower plants
2. Understanding of constructional features of hydraulic machines
3. Analyze the energy conversion in different hydraulic machines
4. Apply knowledge gained from this subject for design relevant purpose of these machines
5. Evaluate the performance characteristics of hydraulic devices.

1. General Concepts

Impulse momentum principle, Jet impingement on stationary and moving plates, Jet impingement on stationary or moving vanes with jet striking at center and tangentially at one end of the vane, Calculations for force exerted, work done and efficiency of the jet, Main components of a turbomachine and its classification various basis, Euler's equation for energy transfer in turbomachines and expressing the energy transfer in terms of fluid and rotor kinetic energy changes **4 Hrs**

2. Basics of Hydropower plants

Introduction, Essential components of hydro-electric power plant, Classifications of hydro-electric power plants - High head power plants, Medium head power plants, Low head power plants, Advantages and disadvantages of a hydroelectric power plant, Classifications of hydraulic turbines, Various heads, discharge and efficiencies related to turbines **3 Hrs**

3. Impulse Turbine

Main Components and working of a Pelton turbine, Velocity triangles for different runners, Work output, Effective head, Power and efficiency of a Pelton turbine**,** Design aspects such as mean diameter of runner, jet ratio, number of jets and number of buckets with working proportions etc. **4 Hrs**

4. Reaction Turbines

Components, parts and operations of Francis and Kaplan turbines, Velocity triangles and work output, Working proportions and design parameters for runners, Degree of reaction, Function of draft tubes and its types, Function and brief description of commonly used surge tanks, Governing of turbines **6 Hrs**

5. Centrifugal Pumps

Main elements of centrifugal pump and their functions, Classification of centrifugal pumps, Pressure changes in a pump- suction, delivery and manometric heads, Vane shape and its effect on head capacity relationships, Departure from Euler's theory, Pump output and efficiency, Minimum starting speed for a centrifugal pump, Priming and priming devices, Multistage pumps-series and parallel arrangement, Submersible pumps, Pumps- field problem and causes and remedies **5Hrs**

6. Similarity Relations and Performance Characteristics

Unit quantities, Specific speed, Model relationships, Scale effect, Cavitation and Thoma's cavitation number, Concept of Net positive suction head (NPSH) and its applications to determine the pump /turbine setting **5 Hrs**

7. Reciprocating pumps

Main Components of reciprocating pumps and their working, slip in reciprocating pumps, Pressure variations due to piston acceleration, acceleration effects in suction and delivery pipes, indicator diagrams, work done against friction, Maximum possible vacuum during suction stroke, Air vessels **4 Hrs**

8. Hydraulic Devices and Systems

Construction and working of simple and differential hydraulic accumulator, Intensfier,Hydraulic coupling and torque converter, Air lift and jet pumps, gear, vane and piston pumps, Hydraulic Ram, Hydraulic lift, Hydraulic Crane **5 Hrs**

SUGGESTED TEXT/REFERENCE BOOKS

1. R.L.Daughaty, Hydraulic Turbines, McGraw Hill
2. Jagdish Lal, Hydraulic Machines, Metropolitan Book Co.
3. D.S.Kumar, Fluid Mechanics and Fluid Power Engineering, SK Kataria and sons
4. K.Subramaniam, Hydraulic Machines, Tata McGraw Hill
5. R.K. Purohit, Hydraulic Machines, Scientific Publishers
6. R.K.Bansal, Fluid Mechanics and Hydraulic Machines, Laxmi Publications
7. P.N.Modi and S.M. Seth, Hydraulics and Fluid Mechanics, Rajson Publications

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BTME 603C: MECHANICAL MEASURMENTS AND METROLOGY

Semester	VI					
Course code	BTME 603C					
Category	Advance Diploma Course -2 (B.Tech)					
Course title	Mechanical Measurements and Metrology (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

COURSE OBJECTIVES

This subject has been designed to provide knowledge about measurement systems and their components. The students will also be able to learn about various sensors and transducers used for measurement of mechanical quantities, usage of various measuring instruments and metrology of screw, gear and surface texture.

COURSE OUTCOMES

After undergoing this course, the student will be able to:

1. Interpret characteristics of measuring instruments.
2. Describe various industrial metrological instruments for measuring linear, angular, screw thread and gear profiles.
3. Apply the fundamental principles for measurement of various mechanical quantities like Force/torque etc.
4. Develop an ability of problem solving and decision making by identifying and analyzing the cause for variation and recommend suitable corrective actions for quality measurements.

1. **Mechanical Measurement Systems**
   Need of mechanical measurement, basic and auxiliary functional elements of a measurement system Basic definitions: Hysteresis, Sensitivity, Linearity, Resolution, Threshold, Drift, Zero stability, loading effect and system response. Dead Time and dead zone, Measurement methods, Generalized Measurement system, Static performance characteristics, Errors and their classification.
2. **Sensors and Transducers**
   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, Introduction to signal processing and conditioning.
3. **Linear and Angular Measurements**
   Vernier calliper, Micrometer, Interval measurements: Slip gauges, Checking of slip gauges for surface quality, Optical flat, Limit gauges.
4. **Measurement of Force, Torque and Strain**:
   Load cells, cantilever beams, proving rings, differential transformers. Torsion bar dynamometer, Servo controlled dynamometer, Absorption dynamometers. Power Measurements. Mechanical strain gauges, Electrical strain gauges, strain gauge material, gauge factors, theory of strain gauges, bridge arrangement, temperature compensation.
5. **Displacement, Velocity/Speed and Acceleration Measurement**
   Working principal of Resistive Potentiometer, Linear variable differential transducers (LVDT), Electro- Magnetic Transducers, Mechanical, Electrical and Photoelectric Tachometers, Piezoelectric Accelerometer, Seismic Accelerometer
6. **Temperature Measurement**
   Thermocouples, Resistance Temperature Detectors, Thermistor, Liquid in glass Thermometers, Pressure Thermometers, Pyrometer, Bimetallic strip. Calibration of temperature measuring devices.
7. **Metrology**
   Basics of Metrology, Line end and wavelength standards, Need for Inspection, Accuracy and Precision, Objectives, Standards of measurements.
8. **Metrology of Gears and Screw Threads**
   Sources of errors in manufacturing of gears, Measurement of toothThickness: Gear tooth Vernier, Constant chord method, Addendum comparator method and Base tangent method, Measurement of tooth profile: Tool maker's microscope or projector, Involute tester, Measurement of pitch, Measurement of run out, Lead and Backlash

checking. Measurement of concentricity, Alignment of gears. Errors in threads, screw thread gauges, measurement of element of the external and internal threads, thread calliper gauges.

9. Metrology of Surface Finish

Concepts and terminology, Analysis of surface traces, Specification of surface Texture characteristics, Method of measuring surface finish: Stylus system of measurement, Stylus probe instruments, Wave length, frequency and cut off, other methods for measuring surface roughness: Light Interference microscopes, Mecrin Instruments

10. Comparators

Functional Requirements, Classification, Mechanical Comparators, Mechanical, Optical Comparators, Electrical Comparators, Pneumatic Comparators.

11. Miscellaneous Metrology

Precision Instrumentation based on Laser Principals, Coordinate measuring machines: Structure, Modes of Operation, Probe, Operation and applications. Optical Measuring Techniques: Tool Maker's Microscope, Profile Projector, Optical Square. Basics of Optical Interference and Interferometry, Optoelectronic measurements

RECOMMENDED BOOKS

1. E.O Doebelin, Measurement System: Application and Design, McGraw Hill
2. J.P Holman, Experimental Methods for Engineers, McGraw Hill
3. D.S Kumar, Mechanical Measurement and Control, Metropolitan Book Co.
4. R.K Jain, Engineering Metrology, Khanna Publishers
5. B.C Kuo, Automatic Control systems, Prentice Hall

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BTME 604C: REFRIGERATION & AIR CONDITIONING LAB

Semester	VI					
Course code	BTME 604C					
Category	Professional Core Course (B.Tech. ME)					
Course title	Refrigeration & Air Conditioning Lab (Practical)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	0	0	2	30	20	01

COURSE OBJECTIVES

This course has been designed to introduce the students for hands on practice to perform the experiment and evaluate the experimental record pertaining to refrigeration cycles of various refrigeration systems. The motive is also to impart the students with training of interfacing the theoretical and practical skills of Refrigeration and Air Conditioning and its primary components such as evaporators, condensers, capillary tubes, expansion valve etc.

COURSE OUTCOMES

After successful completion of this course the students will have:

1. Demonstrate knowledge and application of basic concepts and terminology.

2. Demonstrate knowledge and application of various controls in HVACR systems.
3. Demonstrate knowledge of refrigeration and its application in troubleshooting and servicing HVACR systems.
4. Demonstrate an understanding of the mathematics and science involved in the operation of HVACR systems.
5. Demonstrate by performing experiments, the working of basic refrigeration machines such as window air conditioner, Ice Plant, Mechanical Heat Pump.

LIST OF PRACTICALS

1. To find out the coefficient of performance of vapour compression refrigeration test rig using (a) Capillary tube as an expansion valve. (b) Thermostatic expansion valve.
2. To find out the EPR (Energy Performance Ratio) of a Mechanical Heat Pump based on vapour compression refrigeration cycle.
3. To study the working of Electrolux vapor absorption refrigeration systems using three fluids.
4. To study the window type air conditioning test rig and performing the experiments related to basic air conditioning processes.
5. To study the ice plant test rig.
6. To study the effect of variation of brine concentration on the formation of ice.
7. To study the cut sections of reciprocating compressor of window type air conditioner.
8. To study the working of window air conditioner.
9. Visit to a central Air conditioning plant for study of processes for winter and summer air conditioning.
10. Visit to a cold storage for understanding its working.

*Apart from above experiments Numerical problem / assignment may also be taken up during Lab session.

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BTME 605 C: FLUID MACHINERY LAB

Semester	VI					
Course code	BTME 605C					
Category	Professional Core Courses (B.Tech. ME)					
Course title	Fluid Machinery Lab (Practical)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	0	0	2	30	20	01

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Understand the various features of turbine and pumps
2. Understand the working of various hydraulic machines viz. turbines and pumps

3. Apply the studied concepts to measure the various performance parameters of hydraulic devices
4. Evaluate the features of different hydraulic devices by comparing the performance characteristics.

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LIST OF PRACTICALS

1. To determine the various efficiencies of the hydraulic Ram
2. To study and draw the characteristics of the Pelton turbine
3. To study and draw the characteristics of the Francis/Kaplan turbine
4. To study the various characteristics of a centrifugal pump.
5. To study the constructional features of reciprocating pump and to perform test on it for determination of pump performance
6. To study the constructional features of a jet pump and determine efficiency of a jet pump
7. To study the effect of vane shape and vane angle on the performance of a centrifugal pump / blower
8. A visit to any hydroelectric power station

BTME 606 C: MECHANICAL MEASUREMENTS AND METROLOGY LAB

Semester	VI					
Course code	BTME 606C					
Category	Advance Diploma course -2 (B.Tech. ME)					
Course title	Mechanical Measurements and Metrology Lab (Practical)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	0	0	2	30	20	01

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Demonstrate the use of instruments for measuring linear (internal and external), angular dimensions and surface roughness.
2. Identify proper measuring instrument and know requirement of calibration, errors in measurement etc.
3. Apply analytical and experimental methods to make measurements and to find and correct defects in measurement systems.

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LIST OF PRACTICALS

1. Vernier Calliper/ vernier height gauge: Principle of vernier scale to measure internal and external dimensions including depth

2. Micrometer and Vernier micrometer: concept, principle and use
3. Sine bar and slip gauges and angle gauge: principle and applications
4. Surface texture: Roughness of machined and un-machined plane and spherical surfaces
5. Profile projector: to measure screw and gear elements
6. Three wire method: Diameter of external V-threads
7. Tool makers microscope: to measure screw and gear elements
8. Dead weight gauge: calibration of pressure gauges
9. Stroboscope: measure speed of rotating elements
10. Thermocouple: principle, applications and preparation
11.

BTHU 901C: PERSONALITY DEVELOPMENT

Semester	VI					
Course code	BTHU 901C					
Category	Humanities & Management Course (B.Tech. ME)					
Course title	Personality Development (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

Unit 1

Personality: Personality: Definition & Relevance, Importance of nature & nurture in Personality Development.

Understanding of Self: Self concept, Self identity, Self image, Self esteem, High and low Self esteem, Self awareness, Techniques of self awareness: Exploration through Johari Window, Self Acceptance and self realization

Unit 2

Emotional Intelligence -Meaning, components, Importance and Relevance positive and Negative emotions, Healthy and Unhealthy expression of emotions, Anger: Conceptualization and Cycle

Developing Emotional Competence: Understanding & Developing positive emotions, Positive approach towards future Resilience during loss and challenge, Developing emotional and interpersonal competence, Self assessment, analysis and action plan

Unit 3

Significance of Positive Attitude: Building Positive Attitude Meaning and nature of attitude Components and types of attitude, Importance and relevance of attitude

Motivation: Concept, Significance- Internal and external motives- Importance of self motivation- Factors leading to de-motivation

Self- efficacy: Meaning, Sources and Significance

Unit 4

Stress Management: Meaning & Nature, Types of stress, and Stages of stress, Causes and symptoms of stress, Consequences of stress, Strategies for stress management

Components of Excellence: Time Management: Importance of Time Management, Techniques of Time Management, Assertiveness Training, Handling criticism and interruptions, Building independence & Interdependence, Reducing resistance to change.

SUGGESTED TEXT/REFERENCE BOOKS:

1. Organizational Behaviour,Davis ,K.Hoover, Judhith D.Effective Small group and Team Communication,2002,Harcourt College Publishers
2. Dick,McCann & Margerison,Charles: Team Management ,1992 Edition,Viva Books Bates,A.P. and Jullian,J: Sociology-Understanding Social Behaviour
3. Dressler,David and Cans,Donald: The Study of Human Interaction Lapiere.Richard,T-Social Change
4. Lindzay,G and Borgatta,E: Sociometric Measurement in the Hanbook of Social Psychology, Addison- Wesley,US,Rose G: Oxford Textbook of Public Health,Vol4,1985
5. J William Pfeiffer (ed.) Theories and models in Applied Behavioral Science, Vol.2, Group (1996); Pfeiffer & Company
6. Smither Robert D; The Psychology of Work and Human Performance,1994,Harper Collins College Publishers
7. Charles S.Carver,Michael F,Scheier, Perspectives on Personality ,Pearson New International Edition,7th Edition

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DEPARTMENT ELECTIVE SUBJECTS

(6th SEMESTER)

BTME 611C: PRODUCT DESIGN AND DEVELOPMENT

Semester	VI					
Course code	BTME 611C					
Category	Departmental Elective -II (B.Tech)					
Course title	Product Design and Development (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

COURSE OUTCOMES:

After successfully completing this course, the students/learners will be able to:

1. Understand desirable design aspects considering various production processes and also understand the economic factors of design.
2. Employ engineering, scientific, and mathematical principles to execute a design from conceptto finished product
3. Apply the modern approaches to product design considering concurrent design, quality function deployment and various rapid prototyping methods.
4. Apply innovative process techniques in synthesizing information, problem-solving and criticalthinking.

1. **Introduction to Product Design**: Design by Evolution and Innovation, Essential factors of product design, Production consumption cycle, Flow and value addition in Production consumption cycle, The Morphology of Design, Primary design phases and flowcharting, Role of Allowances, process capability and tolerances in detailed design and assembly
2. **Product Design and Industry:** Product Strategies, Time to Market, Analysis of the Product, Standardization, Simplification and specialization, Basic design considerations, Role of Aesthetics in product design, Functional design practice
3. **Design for Production:** Producibility requirements in the design of machine components, Forging design, Pressed component design, Casting design for economical molding, eliminating defects and features to aid handling, Design for machining ease, the role of process Engineer, Ease of location and Clamping, Some additional aspects of production design, Design of powder metallurgical parts.
4. **Economic Factors Influencing Design:** Product value, Design for safety, reliability and Environmental considerations, Manufacturing operations in relation to design, Economic analysis, profit and competitiveness, break even analysis.
5. **Modern Approaches to product Design:** Concurrent Design, Quality Function Deployment (QFD).
6. **Rapid Prototyping**: Principle of Rapid Prototyping, Rapid Prototyping Technologies (RPT), RPT in Industrial Design.

RECOMMENDED BOOKS:

1. Kail T Ulrich and Steven D Eppinger, Product Design and Development
2. AK Chitale and Gupta, Product Design and Development
3. Middendorf Marcel Dekker ,Design of Systems and Devices

BTME 612 C: QUALITY CONTROL AND SIX SIGMA

Semester	VI					
Course code	BTME 612 C					
Category	Departmental Elective -II (B.Tech)					
Course title	Quality Control and Six Sigma (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

COURSE OUTCOMES:

After studying this course, students shall be able to

1. Understand the Quality, Quality Control and Six Sigma Concepts.
2. Construct and apply various types of Control Charts.
3. Understand the concept of Acceptance Sampling and its application in Industry.
4. Select and apply appropriate quality control technique

1. Introduction to Quality: Concept of Quality and Quality Control economics of quality, functions of inspection in quality control, Organization for inspection and quality. Specifications, tolerance and process capability studies. Total Quality Control, Quality Assurance, and quality system. Concept of quality circles and structure. Use of decision trees and simulation in process control, Quality incentives and TQM.

2. Control of Quality: Definition of control, scope of sampling inspection, application of statistical tools for analyzing data. Control chart theory, Charts for variable and ranges, procedure for constructing and maintaining X-R control charts, Charts for standard deviation, fraction defective and number of defects per units.

3. Acceptance Sampling: Concept of acceptance sampling, sampling by attributes, construction and use of operating characteristics curve, single and double sampling plans, use of Dodge Roming and military standard sampling tables, Continuous and multiple sampling plans.

4. Six Sigma: Concept and Evolution of Six Sigma, Importance of Six Sigma, DMAIC Training, Difference between TQM and Six Sigma, Applications of Six Sigma in Indian Industries, Six Sigma Concept of Process Capability.

RECOMMENDED BOOKS

1. Juran, "Quality Planning and analysis" McGraw Hills.
2. Grants, "Statistical Quality Control", McGraw Hills
3. Duncan, Richard, A. J. Irvin, D."Quality Control and Industrial Statistics".
4. Mahajan, M., "Statistical Quality Control", Dhanpat Rai & Co.

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BTME 613C: MECHATRONICS

Semester	VI					
Course code	BTME 613C					
Category	Departmental Elective -II (B.Tech)					
Course title	Mechatronics (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

COURSE OUTCOMES

After successfully completing this course the students will be able to:

1. Design mux, demux, flip-flops, and shift registers.
2. Describe the block diagram, registers, ALU, bus systems, timing & control signals, instruction cycles, and interrupts of 8085 microprocessors.
3. Apply the concept of 8085 microprocessor instruction sets and addressing modes in writing assembly language program for a given problem.
4. Describe the interfacing of memory, 8255 PPI, ADC, DAC, 7-segment LED system, stepper motor, 8251 and 8253 ICs with 8085 microprocessor

1. **Introduction:** Definition of Mechanical Systems, Philosophy and approach; Systems and Design: Mechatronics approach, Integrated Product Design, Modeling, Analysis and Simulation, Man-Machine Interface;
2. **Sensors and Transducers**: classification, Development in Transducer technology, Optoelectronics-Shaft encoders, CD Sensors, Vision System, etc.
3. **Drives and Actuators**: Hydraulic and Pneumatic drives, Electrical Actuators such as servo motor and Stepper motor, Drive circuits, open and closed loop control
4. **Embedded Systems**: Hardware Structure, Software Design and Communication, Microprocessors and microcontrollers: Microprocessor systems, Microcontrollers, Applications, programmable logic controller, Basic PLC structure, input and output units, Programmable Logic Devices, Input/output processing, Ladder programming,
5. **Smart materials**: Shape Memory Alloy, Piezoelectric and Magneto strictive Actuators: Materials, Static and dynamic characteristics, illustrative examples for positioning, vibration isolation, etc.; Micro mechatronic systems: Microsensors, Mechatronic systems: Mechatronic designs, Case studies.

RECOMMENDED BOOKS

1. Devdas Shetty & Richard A. Kolk, Mechatronics System Design, PWS Publishing Company (Thomson Learning Inc.)
2. William Bolton Mechatronics: A Multidisciplinary Approach, , Pearson Education
3. R.K. Rajput, S A Textbook of Mechatronics,. Chand & Company Private Limited
4. William Bolton Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, , Prentice Hall

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BTME 614 C: NON TRADITIONAL MACHINING

Semester	VI					
Course code	BTME 614 C					
Category	Departmental Elective -II (B.Tech)					
Course title	Non Traditional Machining (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

COURSE OBJECTIVES

The objectives of this course are:

1. To learn various concepts related to modern machining processes & their applications.
2. To appreciate the differences between conventional and non-conventional machining processes.
3. To acquire a functional understanding of non-traditional manufacturing equipment.
4. To know about various process parameters and their influence on performance and their applications.
5. To impart knowledge on various types of energy involved in non-traditional machining processes.

COURSE OUTCOMES

After successful completion of this course, this course will:

1. Provide knowledge to the students so that they should be able to understand nontraditional machining process and need for it.
2. Provide knowledge to the students so that they should be able to understand constructional features and performance of USM.
3. Student should be able to understand constructional features and performance of AJM.
4. Student should be able to understand constructional features and performance of WJM,ECM,CHM and EDM

1. **Modern Machining Processes**:
   An Overview, trends in Manufacturing machining, transfer machining, flexible machining system, Computer integrated manufacturing
2. **Advanced Mechanical Processes**:
   Ultrasonic machining and Abrasive Flow Machining-elements of process, Applications and limitations

3. **Electrochemical & Chemical Removal Processes**:
Principle of operation, elements and applications of Electrochemical Machining, Electrochemical grinding, Electrochemical deburring, Electrochemical honing, Chemical Machining:

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

5. **Hybrid Machining Processes**:
Concept, classification, application, Advantages

SUGGESTED TEXT BOOKS:

1. Modern Machining Processes by P.C. Panday and H.S. Shan, Tata Mc Graw Hill
2. Fundamentals of Machining and Machine Tools by G. Boothroyd and W.A. Knight, Mareel Dekker Inc.
3. Non Traditional Manufacturing Processes, G.F. Benedict, Marcel Dekker Inc.

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BTME 615 C: POWER PLANT ENGINEERING

Semester	VI					
Course code	BTME 615 C					
Category	Departmental Elective -II (B.Tech)					
Course title	Power Plant Engineering (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

COURSE OBJECTIVES

This course aims to focus the students on power generation principles for real world applications. The basic knowledge of different types of power plants i.e. thermal power plants, hydro-power plants, diesel & gas turbine power plants and nuclear power plants to be imparted with understanding of site selection criteria, power plants economics, energy storage etc. including direct energy conversion systems.

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Explain the basics of Power Plants.
2. Describe and analyze different types of sources and mathematical expressions related to thermodynamics and various terms and factors involved with power plant operation.

3. Analyze the working and layout of steam power plants and the different systems comprising the plant and discuss about its economic and safety impacts.
4. Describe the working principle and basic components of the nuclear power plant and the economic and safety principles involved with it.
5. Discuss the working principle and basic components of the hydro electric plants and the economic-safety principles.
6. Have broad view about the power generation by renewable and non-renewable energy resources.

1. **Introduction**
   Energy sources for generation of electric power, Principles types of power plants-their special features and applications, Present status and future trends.
2. **Hydro-Electric Power Plants**
   Classifications, Components and their general layout, Hydro-electric survey, rainfall run-off, hydrograph, flow duration curve, mass curve, storage capacity, Site selection.
3. **Steam Power Plant**
   General Introduction, Developing trends, Essential features, Site Selection, Coal & its storage, preparation, handling, feeding and burning, Ash handling, Dust collection, High pressure boilers.
4. **Diesel and Gas Turbine Power Plants**
   Field of use, Components, Plant layout, Comparison with stream power plants, Operation of combined steam and gas power plants.
5. **Nuclear Power Plant**
   Nuclear fuels, nuclear energy, Main components of nuclear power plant, Nuclear reactors-types and applications, Radiation shielding, Radioactive waste disposal, Safety aspects.
6. **Power Plant Economics**
   Load curves, terms and conditions, Effect of load on power plant design, methods to meet variable load, prediction of load, cost of electric energy, Selection of types of generation and generating equipment, Performance and operating characteristics of power plants, Load division among generators and prime movers, Tariff methods of electric energy. Non-Conventional Power Generation: Geothermal power plants, Tidal power plants, Wind power plants, Solar power plants, Electricity from city refuge.
7. **Direct Energy Conversion Systems**
   Thermoelectric conversion system, Thermionic conversion system, Photo voltaic power system, Fuel Cells, Magneto-hydrodynamic system.

RECOMMENDED 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.

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BTME 616 C: TOTAL QUALITY MANAGEMENT

Semester	VI					
Course code	BTME 616 C					
Category	Departmental Elective-II (B.Tech)					
Course title	Total Quality Management (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

1. **Quality and Total Quality Management:** Excellence in manufacturing/service, factors of excellence, relevance of TQM.
2. **Concept and definition of quality:** Total quality control (TQC) and Total Quality Management (TQM), salient features of TQC and TQM. Total Quality Management Models, benefits of TQM.
3. **Just-in-time (JIT):** Definition: Elements, benefits, equipment layout for JIT system, Kanban system MRP (Material Requirement planning) vs JIT system, Waste elimination, workers involvement through JIT: JIT cause and effect chain, JIT implementation.
4. **Customer:** Satisfaction, data collection and complaint, redressal mechanism.
5. **Planning Process:** Policy development and implementation; plan formulation and implementation.
6. **Process Management:** Factors affecting process management, Quality function development (QFD), and quality assurance system.
7. **Total Employees Involvement (TEI):** Empowering employees: team building; quality circles; reward and Recognition; education and training, Suggestion schemes.
8. **Problems solving:** Defining problem, Problem identification and solving process, QC tools.
9. **Benchmarking:** Definition, concept, process and types of benchmarking.
10. **Quality Systems:** Concept of quality system standards: relevance and origin of ISO 9000; . Benefits; Elements of ISO 9001, ISO 9002, ISO 9003.
11. **Advanced techniques of TQM:** Design of experiments: failure mode effect analysis: Taguchi methods.

RECOMMENDED 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.

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7th SEMESTER

BTME 701C: MECHANICAL VIBRATIONS

Semester	VII					
Course code	BTME 701C					
Category	Professional Core Course (B.Tech. ME)					
Course title	Mechanical Vibrations (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	1	0	40	60	04

COURSE OBJECTIVES

This course aims to provide the overview of mechanical vibrations to mechanical engineering students .The students will be able to use of methods of vibration analysis.

COURSE OUTCOMES

After successful completion of this course the students will have:

1. Formulate mathematical models of problems in vibrations using Newton's second law or energy principles
2. Understand the need and measurement of vibration in mechanical systems
3. Calculate principal modes of vibration
4. Explore the suitable methods of vibration reduction and absorption
5. Ability to determine vibratory responses of SDOF and MDOF systems
6. Create the mathematical model of a vibratory system to determine its response

UNIT I : Introduction, Classification of Vibration Systems, Harmonic motion, Vector representation of harmonic motion, Natural frequency & response, Effects of vibration, superposition of simple harmonic motions, beats, Single Degree Freedom System, Equation of motion, Newton's method, D'Alembert's principle, Energy method etc., Free vibration, Natural frequency, Equivalent systems, Displacement, Torsional vibrations, Damped vibrations, Vibrations of systems with viscous damping, Logarithmic decrement, Energy dissipation in viscous damping.

UNIT II: Single Degree Freedom, Forced Vibration, Harmonic excitation with viscous damping, steady state vibrations, forced vibrations with rotating and reciprocating unbalance, support excitation, Vibration isolation, Transmissibility, Vibration measuring instruments, Displacement, velocity and acceleration measuring instruments.

UNIT III : Two Degree Freedom systems, Introduction, Principal modes, Double pendulum, Torsional system with damping, Principle of vibration absorber, Undamped dynamic vibration absorbers, Torsional vibration absorber, Centrifugal pendulum absorbers, Vibration isolators and Dampers.

UNIT IV : Multi-degree Freedom system, Undamped free and forced vibrations of multidegree freedom systems, influence coefficients, Reciprocal theorem, Principal coordinates, Continuous systems- Longitudinal vibrations of bars, Torsional vibrations of circular shafts.

UNIT V: Multi Degree Freedom system, Numerical Analysis by Rayleigh's method, Dunkerely's, Holzer's and Stodola methods, Rayleigh-Ritz method 5 Critical speed of shafts, Whirling of uniform shaft, Shaft with one disc with and without damping, Multi-disc shafts, Secondary critical speed.

SUGGESTED TEXT/REFERENCE BOOKS:

1. V. P. Singh, Mechanical Vibrations, Dhanpat Rai & Co.
2. G. K. Groover, Mechanical Vibrations, Jain Brothers, Roorkee.
3. S Bhave, Mechanical Vibrations-Theory & Practice, Pearson Education.
4. N K Grover, Mechanical Vibrations-, PBS Publications.
5. Thomson & Dahleh, Theory of Vibrations with Applications, Pearson Education.
6. L Meirovitch, Elements of Vibration Analysis, McGraw-Hill Education.
7. Tse, Morse & Hinkle Mechanical Vibrations
8. V. Rama Murthy Mechanical Vibrations –, Narosa Publications

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BTME 702C: CAD/CAM

Semester	VII					
Course code	BTME 702C					
Category	Professional Core Course (B.Tech. ME)					
Course title	CAD / CAM (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

COURSE OUTCOMES

After successfully completing this course, the students/learners will be able to:

1. Understand the concept of use of computers in Design and manufacturing.
2. Understand the basic design process and Product life cycle Management.
3. Develop 3D modelling Skills required for product design.
4. Understand the basics of Industrial automation.
5. Understand nature & significance of Machine tools.
6. Develop skills for programming skills required for manufacturing.
7. Understand concept of Industrial Robotics.

1. Fundamentals of CAD

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

2. Geometric Transformations

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

3. Geometric Modeling

Wireframe model: solid modelling: Boundary Representation (B-rep), Constructive Solid Geometry (CSG), Parametric Modelling Technique; Mass, volumetric properties calculations;

surface modelling, concepts of hidden-line removal and shading: Mechanical Assembly Kinematics analysis and simulation.

4. **Representation of Curves and Surfaces**
   Non-parametric and parametric representation of curves. Parametric representation of Hermite Cubic, Beizer and B-spline curves; Surface and its analysis. Representation of Analytical and synthetic surfaces.
5. **Overview of FEM**
   Advantages and applications, recent advance in FEM, FEA software Basic principles and general procedure of FEM.
6. **NC/CNC Machine Tools**
   NC machine tools- basic components coordinate systems; features of NC machine tools. Computerized Numerical Control (CNC): Tooling for NC machines - tool presetting equipment, flexible tooling, tool length compensation, tool path graphics; NC motion control system; Manual part programming, fixed/floating zero. Block format and codes: Computer assisted part programming. DNC and Adaptive Control: Direct numerical control: Adaptive control in machining system; Combined DNC/CNC system.
7. **Group Technology (GT)**
   Part families; part classification and coding system: Group technology machine cells: Advantages of GT.
8. **Computer Aided Process Planning**
   Introduction and benefits of CAPP, Types of CAPP systems, Machinability, Data selection systems in CAPP.
9. **Computer Integrated Manufacturing Systems**
   Basic Concepts of CIM: CIM Definition, The meaning of Manufacturing, Types of Manufacturing systems; Need, Elements, Evolution of CIM; Benefits of CIM; Flexible Manufacturing Systems: Physical Components of an FMS. Types of Flexibility, Layout Considerations; FMS benefits.

SUGGESTED TEXT/REFERENCE 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 Tata McGraw Manufacturing Hill
3. Zeid Ibraham, CAD/CAM - theory and Practice, Tata McGraw Hill
4. P. N Rao, CAD/CAM, Tata McGraw Hill
   C.Elanchezhian,G.Shanmuga Sundar, Computer aided manufacturing (CAM), Firewall Media

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BTME 703C: MECHANICAL VIBRATIONS LAB

Semester	VII					
Course code	BTME 703C					
Category	Professional Core Course (B.Tech. ME)					
Course title	Mechanical Vibrations Lab (Practical)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	0	0	2	30	20	01

COURSE OUTCOMES

After successful completion of this course the students will have:

1. Formulate mathematical models to determine the natural frequency of coupled pendulum and cantilever beam.
2. Understand the need and measurement of vibration in mechanical systems.
3. To study the dynamic absorber.

LIST OF PRACTICALS

1. Determine the viscosity of given fluid by single wire tensional pendulum.
2. Determine the natural frequencies of a coupled pendulum.
3. Find out the fundamental natural frequency of a cantilever beam
4. Determine the modulus of elasticity from free vibration test
5. Study of forced vibration of a two degree of freedom system under harmonic excitation.
6. Study of a dynamic absorber.
7. Determine the coefficient of dry friction from measurement of natural frequency of vibration of a bar resting on two disks rotating in opposite direction.

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BTME 704C: CAD/CAM LAB

Semester	VII					
Course code	BTME 704 C					
Category	Professional Core Course (B.Tech. ME)					
Course title	CAD/CAM Lab (Practical)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	0	0	2	30	20	01

LIST OF PRACTICALS

A. Introduction to Modeling (using any CAD software):

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

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

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

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

B. Computer Aided Manufacturing (CAM):

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

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

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BTHU 902C: HUMAN RESOURCE MANAGEMENT

Semester	VII					
Course code	BTHU 902C					
Category	Humanities & Management Course (B.Tech. ME)					
Course title	Human Resource Management (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

Introduction: Introduction to Human Resource management and its definition, Functions of human Resource management & its relation to other managerial functions. Nature, Scope and Importance of human Resource management in industry, Role & position of Personnel functions in the organization

Procurement and Placement: Need of Human resource Planning, Process of Human Resource Planning, Methods of Recruitment, Psychological test and interviewing: Meaning and importance of Placement and Induction, Employment Exchanges (compulsory Notification of vacancies)Act 1959,The Contract Labour (Regulation & Abolition) Act 1970

Training & Development: Difference between Training and Development, Principles of Training, Employee Development, Promotion-Merit v/s seniority Performance Appraisal, Carreer Development & Planning.

Job Analysis & Design: Job Analysis: Job description, Job Specification

Job Satisfaction: Job satisfaction and its importance, Motivation, Factors affecting motivation, Introduction to motivation theory; Workers' Participation, Quality of work life

The Compensation Function: Basic concepts in wage administration, Company's wage policy, Job Evaluation, Issues in wage administration, Bonus & Incentives, Payment of Wages Act-1936, Minimum Wages Act 1961

Integration: Human Relations and Industrial Relations; Difference between Human Relations and Industrial relations,Factors required for good Human Relation Policy in Industry; Employee-Employer relationship, Causes and effects of Industrial Disputes; Employee Grievances & their Redressal, Administration of Discipline, Communication in organization, Absenteeism ,Labour Turnnover,Changing face of the Indian work force and their environment, Importance of collective Bargaining, Role of trade Unions in maintaining cordial Industrial Relations

Maintenance: Fringe & retirement terminal benefits, Administration of welfare amenities, meaning and Importance of employee safety, Accidents – Causes & their Preventions, Safety Previsions under the Factories Act 1948; Welfare of employees and its Importance , Social security, Family Pension Scheme, ESI act 1948,Workmen's Gratuity Act 1972, Future Challenges for Human Resource Management

RECOMMENDED TEXT BOOKS

1. T.N. Chabbra- Human Resource Management (Dhanpat Rai & Co.)

RECOMMENDED REFERENCE BOOKS

1. Lowin B.Flippo- Principles of Personnel Management (McGraw Hill)
2. R.C. Saxsena – Labour Problem and Social welfare (K.Math & Co.)
3. A Minappa and M.S. Saiyada- Personnel Management (Tata McGraw Hill)
4. C.B. Mamoria – Personnel Management (Himalaya Publishing House, Bombay)
5. T.N.Bhagotiwal- Economics of Labour and industrial Relations (Sahitya Bhawan Agra)

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DEPARTMENT ELECTIVE SUBJECTS

(7th SEMESTER)

BTME 711 C: PRODUCTION PLANNING & CONTROL

Semester	VII					
Course code	BTME 711C					
Category	Departmental Elective - III (B.Tech)					
Course title	Production Planning & Control (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

1. **Planning:** Necessity of planning, planning for making and buying, types of plans: mathematical planning techniques, quantity standards, frequency standards, financial aspects of planning, analysis of machine capacity, planning for labour.
2. **Production Control:** Functions of production control Deptt., Factors determining control procedure, Types of controls, Routing, definition, routing procedures including bill of materials, route file, routing for two or more items, standard route charts, recent techniques of routing. Progress reporting and expediting methods.
3. **Forecasting:** Importance of forecasting, fields for forecasting: techniques for forecasting sales, conventional and statistical techniques, Regression or Co-relation analysis, short term and long-term trends in business, forecasting demand for spare parts, stock forecast.
4. **Scheduling:** Master schedule, departmental and shop schedule charts for scheduling. Gnatt Charts-loading and scheduling, Sched-U-Graph. Boards for scheduling.
5. **Despatching:** Procedure, types, bulletin boards, plant departmental and shop bulletin boards, material requisition identifications tag. Move ticket, operation tickets, machine control boards. Inspection ticket, Time ticket, communication systems for despatching, follow up.
6. I**nventory control:** Importance of inventory control, purchases & inventory control, factors which affect stocks, methods of inventory control. Budgetary and trend, stock taking, physical, perpetual and running inventories. Ordering quantity to order.
7. **Store-Room Operations:** Location and layout of store-room bins, pans and boxes used for storing, books and documents used in storing, decentralized stores, inspections function of store.
8. **Purchasing:** Planning for purchasing, procurement schedule, purchase requisition, calling tenders, comparative statements, placing order, receiving materials, inspection, entry and payment. Foreign purchases - Imports. Documents and books used in purchasing.
9. **Computer Applications:** Application of computers in production planning and control activities, Material Requirement Planning (MRP), Manufacturing Resource Planning (MRP II).

RECOMMENDED BOOKS:

1. F. G. Moore, "Production Management", Richard D. Irwin
2. John F. Biegel, "Production controls", Prentice Hall
3. K. C. Jain & N. L. Aggarwal, “Production Planning Control & Industrial Management" Khanna Publishers

4. J. G. Monks, "Production / Operations Management", McGraw-Hill
5. Elwood Spencer Buffa, "Modern Production Management", Wiley/Hamilton

BTME 712C: COMPOSITE MATERIALS

Semester	VII					
Course code	BTME 712C					
Category	Departmental Elective - III (B.Tech)					
Course title	Composite Materials (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

COURSE OBJECTIVES

This subject explains the behavior of constituents in the composite materials and enlightens the students about different types of reinforcement. The objectives of this course will also be to develop the students skills in understanding the different manufacturing methods available for composite material and illuminate their knowledge and analysis skills in applying basic laws of mechanics to the composite materials.

COURSE OUTCOMES

Students who have studied this course will have:

1. Identify and understand the basic mechanical behavior of composite materials and make sound prediction on the likely behavior of new combinations of materials.
2. Apply the choices made for using certain types of composites in certain applications with reference to composite properties.
3. Demonstrate a practical understanding of composite properties and fabrication techniques, and to be able to make realistic suggestions for the evaluation of composite behavior, where appropriate.
4. Analyze the micromechanical properties of fiber reinforced composites.

1. Introduction

Introduction to the concept of composite materials, need of composite materials, various engineering applications of composite materials.

2. Reinforcements

Introduction to types of reinforcements, Flexibility, Fiber Spinning Processes, Stretching and Orientation, Glass Fibers, Fabrication, Structure, Properties and Applications, Boron Fibers, Fabrication, Structure and Morphology Residual Stresses, Fracture Characteristics, Properties and Applications of Boron Fibers, Carbon Fibers, Processing, structural Changes Occurring During Processing, Properties and Applications, Organic Fibers, Oriented Polyethylene Fibers, Aramid Fibers, Ceramic Fibers, Oxide Fibers, Nonoxide Fibers, Whiskers, Other Nonoxide Reinforcements, Silicon Carbide in a Particulate Form, Tungsten Carbide Particles, Effect of High-Temperature Exposure on the Strength of Ceramic Fibers, Comparison of different types of Fibers.

3. **Matrix Materials**
   Polymers, Glass Transition Temperature, Thermoplastics and Thermosets, Copolymers, Molecular Weight, Degree of Crystallinity, Stress–Strain Behavior, Thermal Expansion, Fire Resistance or Flammability, Common Polymeric Matrix Materials, Metals: Structure, Conventional Strengthening Methods, Properties of Metals, Need of Reinforcements. Ceramic Matrix Materials: Bonding and Structure, Effect of Flaws on Strength, Common Ceramic Matrix Materials

4. **Interfaces**
   Wettability, Effect of Surface Roughness, Crystallographic Nature of Interface, Interactions at the Interface, Types of Bonding at the Interface, Mechanical Bonding, Physical Bonding, Chemical Bonding, Optimum Interfacial Bond Strength, Very Weak Interface or Fiber Bundle, Very Strong Interface, Optimum Interfacial Bond Strength, Tests for Measuring Interfacial Strength, Flexural Tests, Single Fiber Pullout Tests, Curved Neck Specimen Test, Instrumented Indentation Tests, Fragmentation Test, Laser Spallation Technique.

5. **Polymer Matrix Composites**
   Processing of PMCs, Processing of Thermoset Matrix Composites, Thermoplastic Matrix Composites, Sheet Molding Compound, Carbon Fiber Reinforced Polymer Composites, Interface in PMCs, Glass Fiber/Polymer, Carbon Fiber/Polymer Interface, Polyethylene Fiber/Polymer Interface, Structure and Properties of PMCs, Structural Defects in PMCs, Mechanical Properties, Applications, Pressure Vessels, Recycling of PMCs.

6. **Metal Matrix Composites**
   Types of Metal Matrix Composites, Important Metallic Matrices, Aluminum Alloys, Titanium Alloys, Magnesium Alloys, Copper, Intermetallic Compounds, Processing, Liquid-State Processes, Solid State Processes, In Situ Processes, Interfaces in Metal Matrix Composites, Major Discontinuities at Interfaces in MMCs, Interfacial Bonding in Metal Matrix Composites, Properties, Modulus, Strength, Thermal Characteristics, High Temperature Properties, Creep, and Fatigue, Applications, Electronic-Grade MMCs, Recycling of Metal Matrix Composites.

7. **Ceramic Matrix Composites**
   Processing of CMCs, Cold Pressing and Sintering, Hot Pressing, Reaction Bonding Processes, Infiltration, Directed Oxidation or the Lanxide™ Process, In Situ Chemical Reaction Techniques, Sol–Gel, Polymer Infiltration and Pyrolysis, Electrophoretic Deposition, Self-Propagating High-Temperature Synthesis, Interface in CMCs, Properties of CMCs, Toughness of CMCs, Crack Deflection at the Interface in a CMC, Thermal Shock Resistance, Applications of CMCs, Cutting Tool Inserts, Ceramic Composite Filters, Other Applications of CMCs

8. **Carbon Fiber/Carbon Matrix Composites**
   Processing of Carbon/Carbon Composites, High Pressure Processing, Oxidation Protection of Carbon/Carbon Composites, Properties of Carbon/Carbon Composites, Thermal Properties, Frictional Properties of the Composites, Ablative Properties,

Applications of Carbon/Carbon Composites, Carbon/Carbon Composite Brakes, Other Applications of Carbon/Carbon Composites, Carbon/SiC Brake Disks

9. Multifilamentary Superconducting Composites

The Problem of Flux Pinning, Types of Superconductor, Processing and Structure of Multifilamentary, Superconductors, Niobium–Titanium Alloys, A15 Superconductors, Ceramic Superconductors, Applications, Magnetic Resonance Imaging

RECOMMENDED BOOKS

1. K.K. Chawla, (1998), Composite Materials, Springer-Verlag, New York
2. B.T. Astrom, (1997), Manufacturing of Polymer Composites, Chapman & Hall
3. J.N.Reddy , Composite materials

REFERENCE BOOKS

1. Stuart M Lee, J. Ian Gray, Miltz, (1989), Reference Book for Composites Technology, CRC press
2. Frank L Matthews and R D Rawlings, (2006), Composite Materials: Engineering and Science, Taylor and Francis.
3. D. Hull and T.W. Clyne, (1996), Introduction to Composite Materials, Cambridge University

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BTME 713 C: INDUSTRIAL AUTOMATION & ROBOTICS

Semester	VII					
Course code	BTME 713C					
Category	Departmental Elective - III (B.Tech)					
Course title	Industrial Automation & Robotic (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

COURSE OUTCOMES

After successfully completing this course, the students/learners will be able to:

1. Learn design and implement automated systems using pneumatics.
2. Provide hydraulic solutions for designing automated systems.
3. Design and implement electro-pneumatic/hydraulic solutions for automated systems.
4. Apply PLC programming and implement it on PLC kits.
5. Assemble automated systems using feeders, orienteers and escapement devices

1. Introduction

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

2. Fluid Power

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

3. Basic Hydraulic and Pneumatic Circuits

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

4. Fluidics

Boolean algebra, Truth Tables Logic Gates Coanda effect,

5. Electrical and Electronic Controls

Basics of Programmable logic controllers (PLC) Architecture & Components of PLC, Ladder Logic Diagrams

6. Transfer Devices and feeders

Classification, Constructional details and Applications of Transfer devices, Vibratory bowl feeders, reciprocating tube, Centrifugal hopper feeders

7. Robotics

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

SUGGESTED TEXT/REFERENCE BOOKS:

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

BTME 714 C: STATISTICAL QUALITY CONTROL

Semester	VII					
Course code	BTME 714C					
Category	Departmental Elective - III (B.Tech)					
Course title	Statistical Quality Control (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

1. **Quality:**
   Concept of Quality, Quality Function, Quality Traits, Quality Characteristics, Quality Management, Quality Principles, Quality Policy, Quality System, Quality Planning, Organizing for Quality, Quality of Design, Quality Circles, Total Quality Management
2. **Quality Costs:**
   Quality Costs, Cost of Prevention, Cost of Appraisal, Cost of Internal Failure, Cost of External Failure, Value of Quality, Quality Cost Model, Cost Analysis in Design, Cost Reduction through Quality Improvement.
3. **Inspection:**
   Definition of Inspection, Inspection Planning, Measurement Errors, Objectives of Inspection, Floor/Patrol Inspection, Centralized Inspection, Process Inspection, Final Inspection, Difference between Inspection & Quality Control.
4. **Quality Assurance:**
   Importance, Total Quality Assurance, Management Principles in Quality Assurance, Forms of Quality Assurance, Evaluation of Quality Assurance, Quality Assurance Programme, Quality Assurance Aspects, Quality Assurance Departments.
5. **Quality Control:**
   Total Quality Control, Objectives of Quality Control, Principles of Quality Control, Quality Control Tools, Statistical Quality Control, Control Charts, Construction of Control Charts for Variables (X-R, X-Chart) and Attributes (p, np, C, U Charts), Acceptance Sampling by Attributes, AOQ&OC Curves, Types of Sampling Plans, Analysis of Process Capability, Use of Dodge Roming and Military Standards Sampling Tables.
6. **Quality Management System:**
   Quality Management systems- origin of ISO 9000 series (ISO 9001,9002,9003,9004) ISO 9001:2000, clauses of ISO 9001:2000, overview of QS 9000 series

RECOMMENDED BOOKS

1. M. Mahajan, "SQC", Dhanpat Rai &Sons
2. Grant E.L. & Leavenworth, R.S., "SQC", McGraw-Hill
3. J.M. Juran, E. N. Gryna Jr., "Quality Planning & Analysis", McGraw-Hill
4. Dr. K.C. Arora, "TQM & ISO 14000", S.K. Kataria & Sons
5. J. M. Juran, "Quality Control Handbook", McGraw-Hill

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BTME 715 C: ADVANCED TECHNIQUES IN MANUFACTURING

Semester	VII					
Course code	BTME 715C					
Category	Departmental Elective- III (B.Tech)					
Course title	Advanced Techniques in Manufacturing (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

1. **Additive Manufacturing:** Introduction, General Introduction to reverse engineering, Comparison of Traditional manufacturing with Additive Manufacturing, Computer aided

design (CAD) and manufacturing (CAM) and Additive Manufacturing (AM), Different Additive Manufacturing relevant processes

2. **Rapid Prototyping:** Basic concepts, Direct and Indirect Processes related to Rapid Prototyping, Rapid Tooling and Rapid Manufacturing
3. **Internet of things (IoT) :** Introduction, Sensing & actuation, Communication and Networking, Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Cyber Physical Systems and Next Generation Sensors, Product Lifecycle Management, Augmented Reality and Virtual Reality
4. **Industrial loT and Application:** Industrial Processes, Industrial Sensing & Actuation, Industrial Internet Systems. Industrial IoT-Layers, IIoT Sensing, Processing, IIoT Communication and Networking Industrial IoT Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security
5. **Artificial Intelligence:** Introduction to Artificial Intelligence, Big Data and Advanced Analysis, Cyber security in Industry 4.0, Introduction to Machine Learning and Data Science

SUGGESTED READING/ TEXT BOOKS

1. S. Misra, A. Mukherjee, and A. Roy, Introduction to IoT. Cambridge University Press.
2. S. Misra, C. Roy, and A. Mukherjee, Introduction to Industrial Internet of Things and Industry 4.0. CRC Press.
3. Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing, Andreas Gebhardt Hanser Publishers
4. Rapid prototyping: principle sand applications C.K. Chua, K.F. Leong and C.S. Lim World Scientific

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BTME 716 C: FINITE ELEMENT METHODS

Semester	VII					
Course code	BTME 716 C					
Category	Departmental Elective- III (B.Tech)					
Course title	Finite Element Methods (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

UNIT-I

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

UNIT – II

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

UNIT – III

Analysis of Beams: Element stiffness matrix for two node, two degrees of freedom per node beam element. Finite element modelling of two dimensional stress analysis with constant strain

triangles and treatment of boundary conditions. Finite element modelling of Axisymmetric solids subjected to Axisymmetric loading with triangular elements.

UNIT – IV

Two Dimensional four noded isoparametric elements and Numerical integration. Steady state heat transfer analysis: one dimensional analysis of a fin and two dimensional analysis of thin plate. Analysis of a uniform shaft subjected to torsion. Dynamic Analysis : Formulation of finite element model, element matrices, evaluation of Eigen values and Eigen vectors for a stepped bar and a beam

SUGGESTED TEXT BOOKS

1. Bathe, Finite Element Procedures in Engineering Analysis, Prentice Hall.
2. Chandrupatla and Belegundu, Introduction to Finite Element in Engineering, Prentice Hall.
3. Cook, Concepts and Applications of Finite Element Analysis, John wiley.
4.

8th SEMESTER

BTME 801 C: INDUSTRIAL SAFETY AND ENVIRONMENT

Semester	VIII					
Course code	BTME 801C					
Category	Professional Core Course (B.Tech)					
Course title	Industrial Safety and Environment (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	2	0	0	40	60	02

. COURSE OBJECTIVES

1. To achieve a safe and accident-free workplace
2. To reduce the business's cost to accident compensation and insurance claims related to workplace accidents
3. To ensure a high-morale work environment for a safer and smoother productivity
4. To have competent supervision on the workers to maximize protection

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Apply the basic concepts and fundamentals of environmental health sciences and key environmental health issues.
2. Develop risk assessment concepts and make decisions about environmental health issues.
3. Develop skills in analyzing, sensitizing and managing the community about environmental health issues.
4. Interpret in appropriate biological, chemical and physical terms the potential consequences of exposure to hazardous environmental/occupational agents
5. Diagnose the cause of environmental pollution and design appropriate control measures to improve the health outcomes.
6. Create a job safety analysis by applying the concepts of workplace injury prevention, risk management and environmental laws**.**
7. Develop an arbitrary plan of action to improve the waste disposal methods in urban and rural context

1. Meaning & Need for Safety

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

2. Planning for Safety

Definition, purpose, nature, scope and procedure. Range of planning, variety of plans. Policy formulation and implementation of safety policies.

3. Safety measures in a Manufacturing Organization

Safety and economics, safety and productivity. Employees participation in safety. Safety standards and legislation

4. **Meaning of Environment and need for Environmental control**.
   Factors in industry. Effect of temperature, Illumination, humidity noise and vibrations on human body and mind. Measurement and mitigation of physical and mental "fatigue" Basics of environment design for improved efficiency and accuracy at work.
5. **Ventilation and heat Control**
   Purpose of ventilation. Physiology of heat regulation.Thermal environment and its measurement. Thermal comfort. Indices of heat stress. Thermal limits for comfort, efficiency and freedom from health risk. Natural ventilation. Mechanical ventilation. Air conditioning Process ventilation. Control of heat exposures: control at source, insulation, and local exhaust ventilation. Control of radiant heat, dilution ventilation. Local relief.
6. **Industrial Lighting**
   Purpose of lighting, benefits of good illumination. Phenomenon of lighting and safety. Lighting and the work. Sources and types of artificial lighting. Principles of good illumination. Recommended optimum standards of illumination. Design of lighting installation. Maintenance standards relating to lighting and colour.
7. **Noise & Vibrations**
   Continuous and impulse noise. The effect of noise on man. Noise measurement and evaluation of noise. Noise isolation. Noise absorption techniques. Silencers vibrations: Effect, measurement and control measures.
8. **Environment Standards**
   Introduction to ISO 14000; Environment standards for representative industries.

RECOMMENDED BOOKS

1. Ventilation by Joselin, Edward Arnold
2. Noise Reduction by Beranek, Mcgraw Hill
3. Modern Safety and health Technology by DC Reamer; R. Wiley
4. Industrial Accident Prevention by Heinrich, HW; McGraw Hill
5. The process of Hazard Control by Firenze, RJ; Kendale

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DEPARTMENT ELECTIVE SUBJECTS

(8th SEMESTER)

BTME 811 C: NON-DESTRUCTIVE TESTING

Semester	VIII					
Course code	BTME 811C					
Category	Departmental Elective (B.Tech)					
Course title	Non-Destructive Testing (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

1. **Introduction**: Classification of techniques of material testing, Need and Significance of Non Destructive Testing methods, type of Non Destructive testing methods.
2. **Radiographic Examination:** Radiant energy and radiography, practical applications, X-ray and Gamma – ray equipment, effect of variables on radiographs, requirement of a good radiograph, interpretation of radiograph, safety precautions, Xeroradiography.
3. **Magnaflux Methods:** Basic principles, scope and applications, magnetic analysis of steel bars and tubing magnetization methods, equipment, inspection medium, preparation of surfaces Fluorescent Penetration inspection, Demagnetization.
4. **Electrical and Ultrasonic Methods:** Basic principles, flaw detection in rails and tubes (Sperry Detector), Ultrasonic testing surface roughness, moisture in wood, Detection of defects in ferrous and non-ferrous metals, plastics, ceramics, measurement of thickness, hardness, stiffness, sonic material analyzer, proof tests, concrete test hammer.
5. **Photo elasticity:** Concept and applications of Plane and circular polarization, Photo stress, models.

RECOMMENDED BOOKS

1. H.E. Davies, G.E Troxell and GFW Hauck, The testing of Engg materials, Mc Graw Hill.
2. W.H Armstrong, Mechanical Inspection, Mc Graw Hill.

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BTME 812 C: INDUSTRIAL TRIBOLOGY

Semester	VIII					
Course code	BTME 812 C					
Category	Departmental Elective (B.Tech)					
Course title	Industrial Tribology (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

1. **Introduction:** Tribological considerations, Nature of surfaces and their contact, Physic mechanical properties of surface layer Geometrical properties of surfaces, methods of studying surfaces, Study of contract of smoothly and rough surfaces.
2. **Friction and Wear:** Role of friction and laws of static friction, causes of friction, adhesion theory, Laws of rolling friction, Friction of metals and non-metals; Friction measurements. Definition of wear, mechanism of wear, friction affecting wear, wear measurement, Wear of metals and non-metals.

3. **Lubrication and Lubricants:** Introduction, dry friction, Boundary lubrication, classic hydrodynamics, hydrostatic and hydrodynamic lubrication, Functions of lubricants, Types of lubricants and their industrial uses, properties of liquid and grease lubricants; lubricant additives, general properties and selection.
4. **Special Topics:** Selection of bearing and lubricant, bearing maintenance, diagnostic maintenance of tribological components, lubrication systems, Filters and filtration.

RECOMMENDED BOOKS

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

BTME 813 C: MANAGEMENT INFORMATION SYSTEMS

Semester	VIII					
Course code	BTME 813 C					
Category	Departmental Elective (B.Tech)					
Course title	Management Information Systems (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

COURSE OUTCOMES

After studying this course, students shall be able to:

1. To understand and asses the importance of information and its role in business.
2. To develop data analyzing skills in students to evaluate information and the tools used for information processing.
3. To imbibe theoretical knowledge of MIS in the students and prepare the students technological competitive and make them ready to self-upgrade in the work place.

1. **Information System and Organization:** Role of Management Information Systems in business, Characteristics of Good Management Information System, Sources of Information, Management levels, Structure of Management Information System. Relating systems and information to organization objectives, Identification of organizational information needs and key objectives, Approaches to the development of an organization information system.
2. **Computer Based System:** Operations of a manual information system, Component of Computer information system, Conversion of manual to computer based system, Impact of Computer technology on organization. Data based management, the components of data processing system, logical data structures, the relational models, Database design and definition, File design Considerations, Flat files, hierarchical and multifile structure, report generation, Selecting data-based management system, Life cycle of Information System, Local Area Network (LAN), Internet.

3. **Computer Simulation:** Factors contributing the growth of computer Simulation, Applications of Simulation tools, Benefits of using simulation, Phases of Simulation, Project methodology, Application examples, Selecting Simulation software.
4. **Artificial Intelligence:** The development of expert system. Definition of heuristics. The logic of reasoning, Applications of expert systems in engineering problems.

RECOMMENDED BOOKS

1. Lucas, H.C, The Analysis, design and Implementation of Information System" McGraw Hills.
2. Martin, J, " Managing the data base Engineering" Prentice Hall
3. Murdick, R.G. and Rose, J.E. and Clogett,J.P,"Information System for modern Management, Prentice Hall of India
4. Scott," management Information Systems
5. Ignizio, "Introduction to Expert Systems, McGraw Hills.

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BTME 814 C: INDUSTRIAL ENGINEERING

Semester	VIII					
Course code	BTME 814C					
Category	Departmental Elective (B.Tech)					
Course title	Industrial Engineering (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

1. **Introduction:** Definition and scope of industrial engineering, Functions of industrial engineering department and its organization, Qualities of an industrial engineer, concept of production and productivity.
2. **Concepts of Management:** Functions of Management, Evolution of Management Thought: Taylor's Scientific Management, Fayol's Principles of Management, Douglas Mc-Gregor's Theory X and Theory Y, Mayo's Hawthorne Experiments, Hertzberg's Two Factor Theory of Motivation, Maslow's Hierarchy of Human Needs – Systems Approach to Management.
3. **Designing Organizational Structures:** Concept, Importance and characteristics of organization, Types of organization - Project, matrix and informal organization. Span of control, Delegation of authority.
4. **Management Planning, Decision Making and Control:** Steps, hierarchy, principles and dimensions of planning function, Approaches to decision making, Decision support systems, Basic control process, control parameters, principles of control.
5. **Plant Location & Layout:** Plant location: definition, factors affecting the plant location, comparison of rural and urban sites-methods for selection. Plant layout: Needs for a good layout, Different types viz. Product, process and combination layouts, Introduction to layouts based on the GT, JIT and cellular manufacturing systems, Development of plant layout.

6. **Productivity:** Definition, reasons for low productivity, methods to improve productivity, relation between work-study and productivity.
7. **Work Analysis:** Definition, need and scope of Work Analysis. Method-study: Definition, objectives, step by-step procedure, questioning techniques, charts and diagrams for recording data. Principles of motion economy; Development and installation of new method. Work–measurement: Definition, various techniques of work-measurement such as work-sampling, stopwatch time study & its procedure, Job selection, Equipment and Forms used for work measurement, need for rating operator, methods of rating, allowances and their types, standard time. Standard data techniques.
8. **Value Engineering:** Definition, Types of values, concept, phases and application of value engineering.

RECOMMENDED 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.

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BTME 815 C: JIGS, FIXTURE AND TOOL DESIGN

Semester	VIII					
Course code	BTME 815 C					
Category	Departmental Elective (B.Tech)					
Course title	Jigs, Fixture and Tool Design (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

1. **Process Engineering**: Definition of Process Planning, Contents of Process Plan, Process Operations, Steps of Process Planning, Process Planning Sheet, Planning and Tooling for Low Cost Planning.
2. **Jigs and Fixture:** Principles of jig and fixture design, Principle of degrees of freedoms, methods of locations and clamping, Various devices for location and clamping, indexing devices, Hydraulic and pneumatic actuation of clamping devices, jig bushes, use of standard parts of jig design, type of drilling jigs, milling fixtures, lathe fixture, grinding fixtures and their classification.
3. **Die Design:** Components of die design, design of die blocks, punches and strippers, methods of holding punches, sketches of stock stops, Design procedure for progressive dies, compound dies and combination dies for press tool operation forging die design for drop and machine forging parts.
4. **Tool Layout for Automatics:** Classification of Automatics, Turret type automatic, tool layout procedure, time required for each operation, operation sheet, tool layout, cam layout.

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

RECOMMENDED BOOKS

1. P.C.Sharma, A Textbook of Production Engineering, S.Chand Publication.
2. C. Donaldson, Tool Design, Mc Graw Hill
3. Cole: Tool Design.
4. ASTM, Fundamentals of Tool Design.

BTME 816 C: RENEWABLE ENERGY RESOURCES

Semester	VIII					
Course code	BTME 816 C					
Category	Departmental Elective (B.Tech)					
Course title	Renewable Energy Resources (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

1. **Introduction to Energy Sources:** Environmental Aspects of Power Generation. Heat Transfer from Solar Energy, Physical principles of conversion of solar radiation into heat utilization, Flat Plate Collectors (FPC), Thermal losses and efficiency of FPC, Practical considerations for flat plate collectors, Applications of FPC – Water heating and drying, Focusing Type Collectors: orientation and sun tracking systems, Types of concentrating collectors – cylindrical parabolic collector, compound parabolic collector, Thermal performance of focusing collectors.
2. **Solar Energy Storage System**, Application of solar energy: solar water heating, space heating and cooling, solar photovoltaic, solar cooking, solar distillation & desalination, Solar industrial process heating, Solar power generation. Solar Green Houses, Solar thermo mechanical power, solar refrigeration & air conditioning, Solar ponds.
3. **Energy from Biomass:** Type of biomass sources, Energy plantation, Methods for obtaining energy from biomass, Biomass conversion technologies-wet and dry processes, Biodigestion, Community/Industrial biogas plants, Factors affecting biodigestion, Design of a biogas plant, Classification, advantages and disadvantages of biogas plants, Problems related to biogas plants, Utilization of biogas. Thermal gasification of biomass, Gasifier-classification, chemistry, advantages, disadvantages and application. Alcohol fuels from biomass: overview, feedstock, methods for alcohol production, Ethanol as an alternative liquid fuel; engine performance with alcohol fuels, biodiesel from biomass.
4. **Wind Energy:** Basic principles of wind energy conversion: power in the wind, maximum power, forces on the blades, lift and drag, Components of wind energy conversion systems (WEC), Classification, advantages and disadvantages of WEC systems, Types of wind machines, Performance of wind machines, Design considerations, Energy storage, Application of wind energy, Environmental aspect. Tidal Energy. Components of tidal power plants, Single and double basin arrangements, Estimation of energy and power,

Advantages and limitations of tidal power. Wave energy- its advantages and disadvantages, energy and power from wave energy.

5. **Chemical Energy Sources:** Fuel cells: Design, principle, classification, types, advantages and disadvantages, Work output and EMF of fuel cells, Application of fuel cells, Hydrogen energy, Properties of hydrogen, Methods of hydrogen production, Storage and transportation of hydrogen, Advantages and application.

RECOMMENDED BOOKS

1. G D Rai, 'Non-Conventional Energy Sources', Khanna Publishers. Delhi, 2010
2. S P Sukhatme, 'Solar Energy-Principles of Thermal Collection & Storage', Tata McGraw Hill Publishing Company Ltd., New Delhi
3. John A Duffie & William A Beckman, 'Solar Energy Thermal processes', Wiley Interscience publication.
4. P Garg & J Prakash,' Solar Energy - Fundamentals and Applications', Wiley Interscience publication.
5. Jay Cheng, 'Biomass to Renewable Energy Processes', 1st Edition, CRC press, 2009.

BTME 817 C: WORK STUDY AND ERGONOMICS

Semester	VIII					
Course code	BTME 817C					
Category	Departmental Elective (B.Tech)					
Course title	Work Study and Ergonomics (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

COURSE OBJECTIVES

This course has been designed for students to give knowledge for improvement of manufacturing processes, procedures, working conditions and plant layout and work place layout. This subject will also focus on reducing the human effort and fatigue. This course will also aim at improvement in the utility of material, machines and manpower by adopting safety standard and standardization of methods.

COURSE OUTCOMES

After undergoing this course, the student will be able to:

1. Establish ergonomics in the workplace
2. Introduce basic skills in the recognition & control of ergonomics hazards and ergonomic exercises.
3. Minimize injuries/illness while maximizing productivity and efficiency
4. Understand the correct and effective use of the tools and equipment.
5. Understand hazards and implement control measures.
6. Effective safety training lead to safe work culture, high morale, increased productivity hence high credibility.

1. **Work Study:** Definition and Objective of Work Study, Scope of Work Study, Advantages of Work Study, Techniques of Work Study, Work Study and Management, Work Study and Productivity
2. **Method Study:** Objectives and Procedure of Method Study, Selection of job, Various recording techniques like outline process charts, flow process charts, man machine charts, two handed process charts, string diagram, flow diagram, multiple activity chart, SIMO chart and micro motion study, cyclographs and chrono-cyclographs, Process Chart Symbols, Therblig
3. **Work Measurement:** Definition and Objectives of Work Measurement, Work measurement techniques, basic procedure of work measurement.
4. **Time Study:** Definition of Time Study, Difference between Time Study and Motion Study, Basic Procedure for Time Study, Time study equipment, Job evaluation and incentive schemes Various Time Estimates and Production Standard, Level of Performances, Allowances, allowances and standard time determination
5. **Ergonomics:** Concept of Ergonomics, Objectives of Ergonomics, Man Machine System Interface, Anthropometry, Ergonomics and Safety, Fatigue in Workers, Quantitative qualitative representation and alphanumeric displays, control types, relation between controls and displays, Design of work places, influence of climate on human efficiency. Influence of noise, vibration and light.

RECOMMENDED TEXT/ REFERENCE BOOKS:

1. Suresh Dalela and Saurabh, Work study and Ergonomics , Standard Publishers
2. R. M. Bernes, Motion and Time Study, John-Wiley & Sons, 2001.
3. D.J. Oborne , Ergonomics at Work, John Wiley & Sons
4. Sanders Mark S and McCormick Ernert J, Human Factors in Engineering and Design, McGraw-Hill Inc., 1993.
5. International Labour Organization, "Work-study", Oxford and IBH Publishing company Pvt. Ltd., N.Delhi, 2001

BTME 818 C: MATERIAL MANAGEMENT

Semester	VIII					
Course code	BTME 818 C					
Category	Departmental Elective (B.Tech)					
Course title	Material Management (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

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

2. **Material Planning & Budgeting**
   Need for material planning, Factors affecting material planning, Techniques of material planning, Material classification, codification and standardization, Material budgeting - meaning and need, techniques of material budgeting.
3. **Inventory Control**
   Need and meaning of inventory, types of inventory, functions of inventory control, Inventory costs, Inventory control tool - ABC, VED, XYZ and FSN: Economic order Quantity and replenishment of stocks. Physical control of inventory: Fixed order, Two bin and Kardex systems
   Material requirement planning (MRP-I) Spare parts control for maintenance purposes. Evaluation of inventory control performance. Concept of Just-in-Time (JIT). Use of computers for inventory control
4. **Purchasing**
   Purchasing principles, procedures and systems, Functions of purchasing, Make-or-buy decision, Vendor development and vendor rating. Factors affecting purchase decisions, Legal aspects of purchasing, Documentation and procedure for import.
5. **Storage**
   Functions and importance of store keeping, types of stores, store accounting and store verification, Legal aspects of store keeping, Management of surplus, scrap and obsolete items. Importance of material handling in store keeping, handling equipment.

SUGGESTED TEXT/REFERENCE BOOKS

1. M.M. Verma, Materials Management, S. Chand and Co.
2. Gopal Krishnan and Sundaresan, Material Management -An Integrated Approach, Prentice Hall
3. Dobbler and Burt, Purchasing and materials management, Tata McGraw Hill
4. M. Starr and D. Miller, Inventory control, Prentice Hall.

Department of Mechanical Engineering

(Open Elective Subjects list for 2022 batch & onward Batches)

S.No	Subject Code	Name of Subject
1.	BTME 901C	Operations Management
2.	BTME 902C	Industrial Engineering & Management
3.	BTME 903C	Industrial Automation& Robotics
4.	BTME 904C	Total Quality Management
5.	BTME 905C	Entrepreneurship
6.	BTME 906C	Principle of Management
7.	BTME 907C	Product Design and Development
8.	BTME 908C	Operations Research
9.	BTME 909C	Power Plant Engineering
10.	BTME910C	Computer aided design & Manufacturing
11.	BTME 911C	Non Conventional Energy Resources
12.	BTME 912C	Numerical Methods in Engineering
13.	BTME 913C	Thermo -Fluid Engineering
14.	BTME 914C	Advance Machine Design

BTME 901C: OPERATIONS MANAGEMENT

Semester	IV- VIII					
Course code	BTME 901C					
Category	Open Elective (B.Tech)					
Course title	Operations Management (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

1. **Need and Scope of Operation Management**: Types of production system and their characteristics, productivity definition, types and measurements
2. **Product Design And Development**: Steps involved in product design and development, considerations of technical, ergonomic, aesthetic, economic and time factors. Use of concurrent engineering in product design and development. Discussion of case studies. Feasibility and locational analysis.
3. **Planning And Forecasting**: Role of market survey and market research in pre-planning, long medium and short range forecasting, objective and techniques of forecasting, smoothening and revision of forecast
4. **Production Planning**: Production planning objective and functions, Bill of material, Capacity and man power requirement planning, operation analysis and process planning, long range planning, aggregate planning; Objective, Strategies, graphical and mathematical techniques of aggregate planning, master production scheduling, MRP and MRP II Systems
5. **Production Control**: Capacity control and priority control, production control functions; Routing, scheduling, dispatching, expediting and follow up. Techniques of production control in job shop production, batch production and mass production systems.
6. **Material Management:** Objectives, scope and functions of material management, planning, procurement, storing, ending and inventory control Purpose of inventory, inventory cost, inventory control systems, Selective inventory control systems, Determination of EOQ, Lead time and reorder point. Methods of physical stock control.
7. **Quality Control:** Meaning of quality and quality control, quality of design, quality of conformance and quality of performance, functions of quality control. Introduction to statistical quality control-control charts and sampling plans.
8. **Management Information Systems**: Introduction to MIS, Steps in designing MIS, Role of Computers inMIS.

9. **Maintenance Systems:** Type of maintenance, objective of maintenance, Planned maintenance strategies, preventive maintenance, condition monitoring and total productive maintenance

RECOMMENDED BOOKS:

1. S.N. Charry, Production and Operation Management, Tata-McGraw Hill.
2. J.G. Monks, Production/Operation Management, Tata-McGraw Hill.
3. R.N. Nauhria and Rajnish Prakash, Management of systems, Wheeler Publishing.
4. Elwood S. Buffa, Modern Production Management, John Wiley.
5. E. L. Grant and R.S. Leaven Worth, Statistical Quality Control, McGraw Hill.

BTME 902C: INDUSTRIAL ENGINEERING & MANAGEMENT

Semester	IV- VIII					
Course code	BTME 902C					
Category	Open Elective (B.Tech)					
Course title	Industrial Engineering & Management (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

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

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

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

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

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

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

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

methods of rating, allowances and their types, standard time. Standard data techniques.

8. **Value Engineering:** Definition, Types of values, concept, phases and application of value engineering.

RECOMMENDED 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 903C: INDUSTRIAL AUTOMATION & ROBOTICS

Semester	IV- VIII					
Course code	BTME 903C					
Category	Open Elective (B.Tech)					
Course title	Industrial Automation & Robotics (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

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

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

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

4. Fluidics: Boolean algebra Truth Tables, Logic Gates, Conda effect

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

6. Transfer Devices and feeders: Classification, Constructional details and Applications of Transfer devices, Vibratory bowl feeders, Reciprocating tube, Centrifugal hopper feeders

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

RECOMMENDED BOOKS:

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

BTME 904C: TOTAL QUALITY MANAGEMENT

Semester	IV- VIII					
Course code	BTME 904C					
Category	Open Elective (B.Tech)					
Course title	Total Quality Management (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

1. **Quality and Total Quality Management:** Excellence in manufacturing/service, factors of excellence, relevance of TQM.
2. **Concept and definition of quality:** Total quality control (TQC) and Total Quality Management (TQM), salient features of TQC and TQM. Total Quality Management Models, benefits of TQM.
3. **Just-in-time (JIT):** Definition: Elements, benefits, equipment layout for JIT system, Kanban system MRP (Material Requirement planning) vs JIT system, Waste elimination, workers involvement through JIT: JIT cause and effect chain, JIT implementation.
4. **Customer:** Satisfaction, data collection and complaint, redressal mechanism.
5. **Planning Process:** Policy development and implementation; plan formulation and implementation.
6. **Process Management:** Factors affecting process management, Quality function development (QFD), and quality assurance system.
7. **Total Employees Involvement (TEI):** Empowering employees: team building; quality circles; reward and Recognition; education and training, Suggestion schemes.
8. **Problems solving:** Defining problem, Problem identification and solving process, QC tools.
9. **Benchmarking:** Definition, concept, process and types of benchmarking.
10. **Quality Systems:** Concept of quality system standards: relevance and origin of ISO 9000; Benefits; Elements of ISO 9001, ISO 9002, ISO 9003.
11. **Advanced techniques of TQM:** Design of experiments: failure mode effect analysis: Taguchi methods.

RECOMMENDED 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

BTME 905C: ENTREPRENEURSHIP

Semester	IV- VIII					
Course code	BTME 905C					
Category	Open Elective (B.Tech)					
Course title	Entrepreneurship (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

1. **Concept of Entrepreneurship:** Entrepreneurship and small scale industry need for promotion of entrepreneurship, entrepreneurship development programmes (EDP), personality characteristics of entrepreneur.
2. **Identification of Investment Opportunities:** Governmental regulatory framework, industrial policy, industrial development and regulation act, regulation of foreign collaboration and investment, foreign exchange regulation act, incentives for export oriented units, incentives for units in industrially backward areas, incentives for small scale industry, government assistance to SSI, how to start and SSI, list of items reserved for SSI, Scouting for project ideas, preliminary screening, project identification for an existing company.
3. **Market and Demand Analysis:** Information required for market and demand analysis, market survey, demand forecasting, uncertainties demand forecasting.
4. **Cost of Project and Means of Financing:** Cost of project, means of financing, planning the capital structure of a new company, term loan financial institutions, cost of production.
5. **Financial Management:** Concept and definition of financial management types of capital, of finance, reserve and surplus, concepts and liabilities, profit and loss statement balance sheet, depreciation, methods of calculating depreciation break even analysis.

RECOMMENDED BOOKS:

1. E.D.I. Ahmedabad, Publication regarding Entrepreneurship.
2. Prasanna Chandra, Project Preparation, Appraisal Budgeting and Implementation, McGraw Hill.
3. C.S.Gupta and N.P.Srinivasan, Entrepreneurial Development, S. Chand and co.
4. S. S. Khanka, Entrepreneurship Development Practice and Planning, S. Chand and co.

BTME 906C: PRINCIPLE OF MANAGEMENT

Semester	IV- VIII					
Course code	BTME 906 C					
Category	Open Elective (B.Tech)					
Course title	Principle of Management (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

1. **Introduction:** Definition: nature, scope, importance, Function of management and Manager, Managerial roles and skills; Managerial ethics: need, importance, classification and ethical dilemma, corporate social responsibility, concept, need, tools and strategies, Evolution of management thought and Management thinkers, scientific management, General administrative theories, Quantitative approach, system approach, ,Behavioural approach, contingency approach
2. **Planning:** Importance, types of plans and process of planning, business forecasting, concept, importance, benefits, limitations and process of managing by objectives, Strategic management: Nature, importance, purpose, types, process and major kinds of strategies, Decision making: Importance, types ,steps and approaches, Decision making in various conditions, decision tree
3. **Organizing:** Concept, types, structures and process of organization, Bases of departmentation, Line and staff concept: problems of use of staff and ways to avoid line staff conflict, Authority and Power: concept, responsibility and accountability, Delegation: Concept, importance, factor affecting the delegation, Reason for failure and ways to make delegation effective, span of management. Decentralization vs centralization: concept, reason, types and advantage and disadvantages of decentralization. Coordination: Concept, importance, difficulties and techniques to ensure effective coordination.
4. **Control:** Concept, importance, characteristics, planning control relationship, process of control: setting objectives, establishing standards, measuring performance, correcting derivations, types, process and technique of control, Comparative study: comparative study of main features of Japanese Management and Z culture of American companies, Chinese style Management, Modern management techniques: an overview of various latest techniques: Business

process, business outsourcing, bench marking, knowledge management, total quality management ,Mckinsey's 7-S approach- business Management

RECOMMENDED BOOKS:

1. Heinz Weihrich, Cannice & Koontz, Management (A global Perspective), Tata McGraw Hill
2. Griffin, Management: Principle & Applications, engage Learning
3. Stephen Robbins & Coulter Mary, Management, Pearson Education
4. VSP Rao & VH Krishna, Management, Excel Books
5. P. Subba Rao, Principle of Management, Himalaya Publishing
6. Mukherjee, Principle of Management and organizational behavior, Tata McGraw Hill

BTME 907C: PRODUCT DESIGN AND DEVELOPMENT

Semester	IV- VIII					
Course code	BTME 907C					
Category	Open Elective (B.Tech)					
Course title	Product Design and Development (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

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

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

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

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

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

Books:-

1. W.H. Mayal, Industrial Design for Engineers, London Liifee Books Ltd.
2. Huchingson R. Dale, New Horizons for Human Factors in Design, McGraw Hill.
3. N.L. Svensson, Engineering Design.
4. R. Matousek, Engineering Design.
5. K. J. Mccormick (Ed), Human Factor Engineering, McGraw Hill.

BTME 908C: OPERATIONS RESEARCH

Semester	IV- VIII					
Course code	BTME 908C					
Category	Open Elective (B.Tech)					
Course title	Operations Research (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

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.

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.

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, and inventory models with price breaks. (4)

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

RECOMMENDED 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 909 C: POWER PLANT ENGINEERING

Semester	VII					
Course code	BTME 909 C					
Category	Open Elective (B.Tech)					
Course title	Power Plant Engineering (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

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

2. **Hydro-Electric Power Plants:** Classifications, Components and their general layout, Hydroelectric survey, rainfall run-off, hydrograph, flow duration curve, mass curve, storage capacity, Site selection.

3. **Steam Power Plant:** General Introduction, Developing trends, Essential features, Site Selection, Coal-its storage, preparation, handling, feeding and burning, Ash handling, dust collection, High pressure boilers.

4. **Diesel and Gas Turbine Power Plants:** Field of use, components, Plant layout, Comparison with stream power plants, Operation of combined steam and gas power plants.

5. **Nuclear Power Plant:** Nuclear fuels, nuclear energy, Main components of nuclear powerplant, Nuclear reactors-types and applications, Radiation shielding, Radioactive waste disposal, Safety aspects.

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

7. **Direct Energy Conversion Systems:** Thermoelectric conversion system, Thermionic conversion system, Photo voltaic power system, Fuel Cells, Magneto-hydrodynamic system.

RECOMMENDED 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 910 C: COMPUTER AIDED DESIGN AND MANUFACTURING

Semester	IV- VIII					
Course code	BTME 910 C					
Category	Open Elective (B.Tech)					
Course title	Computer Aided Design and Manufacturing (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

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

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

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

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

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

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

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

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

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

RECOMMENDED BOOKS:

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

BTME 911C: NON CONVENTIONAL ENERGY RESOURCES

Semester	IV- VIII					
Course code	BTME 911C					
Category	Open Elective (B.Tech)					
Course title	Non Conventional Energy Resources (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

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

2. Solar Energy: Solar radiation - beam and diffuse radiation; earth sun angles, attenuation and measurement of solar radiation; Optical properties of materials and selective surfaces; Principles, general description and design procedures of flat Platte and concentrating collectors; Performance analysis of cylindrical and parabolic collectors; Solar energy storage systems - their types, characteristics and capacity; solar ponds. Applications of solar energy in water, space and process heating, solar refrigeration and air conditioning; water desalination and water pumping; solar thermal power generation; solar cells and batteries; economic analysis of solar systems.

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

4. Direct energy conversion systems: i) Magnetic Hydrodynamic (MHD) Generator: gas conductivity and MHD equations; operating principle, types and working of different MHD systems – their relative merits; MHD materials and production of magnetic fields. ii) Thermo-electric generators: Thermo-electric effects and materials; thermo-electric devices and types of thermo-electric generators; thermo-electric refrigeration. iii) Thermionic generators: thermionic emission and materials; working principle of thermionic convertors. iv) Fuel Cells: thermodynamic aspects; types, components and working of fuel cells. v) Performance, applications and economic aspects of above mentioned direct energy conversions systems.

5. Miscellaneous Non-Conventional energy Systems: i) Bio-mass: Concept of bio-mass conversion, photo-synthesis and bio-gasification; Bio gas generators and plants - their types constructional features and functioning; digesters and their design; Fuel properties of bio gas and

community bio gas plants ii) Geothermal: Sources of geothermal energy - types, constructional features and associated prime movers. iii) Tidal and wave energy: Basic principles and components of tidal and wave energy plants; single basin and double basin tidal power plants; conversion devices Advantages/disadvantages and applications of above mentioned energy systems.

RECOMMENDED BOOKS:

1. H.P.Garg and Jai Prakash, Solar Energy: Fundamentals and Applications, Tata McGraw Hill.
2. S.P.Sukhatme,Solar Energy:Principles of Thermal Collection and Storage, Tata McGraw Hill.
3. John A. Duffic and W. A. Beckman, Solar Engineering of Thermal Processes, John Wiley.
4. S. L. Sheldon, Chang, Energy Conversion, Prentice Hall.
5. O. M. Bockris and S. Srinivasan, Fuel Cells, McGraw Hill.

BTME 912 C: NUMERICAL METHODS IN ENGINEERING

Semester	IV- VIII					
Course code	BTME 912 C					
Category	Open Elective (B.Tech)					
Course title	Numerical Methods in Engineering (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

COURSE OBJECTIVES:

This course aims to provide knowledge to engineering students to introduce the fundamentals of numerical methods used for the solution of engineering problems to understand the numerical methods and their applicability to problems of engineering. This course will also improve the computer skills of the students.

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

1. Explain fundamental of various numerical methods.
2. Explain various numerical methods for performing tasks, such as interpolation, differentiation, integration, solution of linear and nonlinear equations, solution of differential and integral equations
3. Explain numerical methods to obtain approximate solutions to mathematical problems and evaluate accuracy of various numerical methods and their applicability.
4. Obtain numerical solutions to problems of engineering

1. **Errors in Numerical Calculations**

   Errors in numerical calculations, Error Analysis: Exact and approximate numbers, rounding off numbers, types of errors encountered in computations, general error formulae, approximations of functions and series, propagation of errors. **(3 hrs)**

2. **Solution of algebraic and Transcendental equations**

   Bisection method, Regula-falsi method, fixed-point iteration, Newton-Raphson method. Solution of systems of non linear equations. **(3 hrs)**

3. **Interpolation methods**

Errors in polynomial interpretation, finite difference, forward, backward and central difference, Difference of a polynomial, Newton's formulae for interpolation, central difference interpolation formulae, Interpolation with unevenly spaced points, Newton's general interpolation formula, and interpolation by iteration. **(5 hrs)**

4. **Curve Fitting**

Cubic splines and approximation: Introduction, Least square curve fitting, Procedures of fitting a straight line, non linear curve fitting, curve fitting by a sum of exponentials, Data fitting with cubic splines-derivation of governing equation, end conditions. **(5 hrs)**

5. **Numerical Differentiation and Integration**

Introduction, Numerical Differentiation, Numerical Integration, Numerical differentiation-cubic spline method: maximum and minimum values of a tabulated function; Numerical Integration- trapezoidal rule, Simpson1/3 rule, Simpsons 3/8 rule, Newton-cots integration formulae; Euler-Meclaurin formula, Gaussian integration(One dimensional only). **(5hrs)**

6. **Matrices and Linear systems of equations**

Introduction, Inverse of Matrix, Solution of linear systems, Matrix inversion method, Gaussian Elimination method (fall and banded symmetric and un-symmetric systems), Eigen value problems. **(5hrs)**

6. **Numerical solution of ordinary differential equations**

Solution by Taylor's series, Prediction -correction method, Boundary value problems, Prediction corrector method, Euler's and modified Euler's method, Runge-Kutta method, finite difference methods. **(5hrs)**

7. **Numerical solution of Partial differential equations**

Finite difference approximation to derivatives, Solution to Laplace's equation- Jacobi's method, Gauss -Siedel method, S.O.R method, Parabolic equation and their solution using iterative methods. **(5hrs)**

RECOMMENDED BOOKS:

1. Niyogi, Pradip, "Numerical Analysis and Algorithms", Tata McGraw –Hill
2. Balagurusamy,E., "Numerical Methods", Tata McGraw –Hill
3. Sastry, S.S., "Introduction Methods of Numerical Analysis", PHI
4. Chapra, S.C. and Canale, R.P., "Numerical Methods for Engineers", Tata McGraw –Hill

BTME 913 C: THERMO-FLUID ENGINEERING

Semester	IV- VIII					
Course code	BTME 913C					
Category	Open Elective (B.Tech)					
Course title	Thermo-Fluid Engineering (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

COURSE OBJECTIVES:

This subject has been designed to understanding of thermal and fluid engineering fundamentals. Motive of the subject is to provide knowledge to the students about various relevant applications i.e turbines, pumps , air compressor etc.

COURSE OUTCOMES

After study of this course, it is expected that students will be able to:

1. Understand steam generators and steam power generation.
2. Understand basic concepts of thermodynamics
3. Analyze various types of air compressor
4. Understand basics of thermodynamics
5. Study of various turbines and pumps

1. **Basics of Thermodynamics.** Thermodynamics: System & Control volume; Property, State & Process; Exact & Inexact differentials; Work-Thermodynamic definition of work; electrical, magnetic, gravitational, spring and shaft work. Zeroth, first and second law of thermodynamics, thermodynamic system and processes. **06Hrs**
2. **Steam Generators:** Introduction, formation of a steam at a constant pressure, temperature Versus total heat graph during steam formation, steam properties, boiler performance, boiler efficiency, equivalent of evaporation and energy balance, Methods of measurement of dryness fraction of steam Construction and working of Fire tube and water tube boilers **06 Hrs**
3. **Air Compressors:** Applications of Compressed air, Introduction, Classifications, working of single stage reciprocating air compressors, work done by a single stage reciprocating air compressors with and without clearance, multistage compression, two stage reciprocating air compressors with intercooler, intercooling of air in a two stage reciprocating air compressors, **06 Hrs**

4. **Basic Concepts of Fluid Mechanics:** Fundamentals of Fluid Mechanics: Introduction; Applications; Concept of fluid; Difference between solids, liquids and gases, Newton's law of Viscosity, classification of fluid: Newtonian & Non- Newtonian fluids, Ideal & Real fluids, Fluid properties: viscosity, compressibility, cohesion, adhesion, surface tension, meniscus effect, vapour pressure, cavitations. Static's of Fluid- Pressure head, Pascal's law, continuity equation , total pressure, total Pressure on an immersed surface, Bernoulli's equation, applications of Bernoulli's equation for flow through devices - Classification of fluids and fluid flows; Measurements of fluid pressure; piezometer and manometers **10Hrs**
5. **Hydraulic Turbines and Pumps:** Impulse momentum principle; Basic components of a turbo machine and its main classification on the basis of purpose; Euler's equation for energy transfer in a turbo machine Construction, working and applications of hydraulic turbines, Construction, working and applications of centrifugal pumps and reciprocating pumps. . **08 Hrs**

RECOMMENDED BOOKS:

1. R.K Bansal Fluid Mechanics and Hydraulic Machines, Laxmi Publication,
2. S.C. Gupta Fluid Mechanics and Hydraulic Machines, , Pearson Education
3. A.K Jain Fluid Mechanics including Hydraulic Machines, Khanna Publishers
4. A. Kumar., Thermal Engineering, Narosa Publishing House
5. P. N. Modi and S. M. Seth Hydraulics and Fluid Mechanics, Standard Book House, New Delhi,
6. R.K. Rajput, Thermal Engineering, Laxmi Publications

BTME 914 C: ADVANCE MACHINE DESIGN

Semester	IV- VIII					
Course code	BTME 914C					
Category	Open Elective (B.Tech)					
Course title	Advance Machine Design (Theory)					
Scheme and Credits	L	T	P	Internal Marks	External Marks	Credits
	3	0	0	40	60	03

COURSE OBJECTIVES:

To provide knowledge of design procedure for simple components like keys, cotters, fasteners, shafts, couplings, pipe joints and levers under static and fatigue loading. Objective of this course is to make the students capable of designing mechanical systems consisting of wide range of machine elements.

COURSE OUTCOMES:

After successfully completing this course, the students/learners will be able to:

1. Demonstrate recalling and applying knowledge of Basic Sciences, Graphics & Drawing, Basic Manufacturing Processes and Material Science, for design procedures of various Mechanical components.
2. Comprehend the effect of different stresses and strains under various loading conditions on the mechanical components and identify the mechanism/mode of failure.
3. Examine and solve design problems involving machine elements on the basis of various theories of failure.
4. Synergize forces, moments and strength information to develop ability to analyze, design and/or select machine elements aiming for safety, reliability, and sustainability.

1. **Introduction:** Meaning of design with special reference to machine design, general design considerations, general procedure of machine design, concept of tearing, bearing, shearing, crushing, bending and fracture. **(2)**

2. **Design of pressure vessels:** Design of shafts under static and fatigue loadings, Design of solid and hollow shafts for transmission of torque, bending moments and axial forces, Design of shaft for rigidity. **(3)**

3. **Design of Pipe Joints:** Stresses in pipes, design of pipe Joints, standard pipe flanges for steam, hydraulic pipe joint for high pressures, design of circular flanged pipe Joint, design of oval flanged pipe joint. **(3)**

4. **Selection of bearings:** Slider: Principle of hydrodynamic lubrication, modes of lubrication, bearing performance parameters, slider bearing design. Roller: Types, selection guidelines, static and dynamic load carrying capacity, Stribeck's equation, equivalent bearing load, load life relationship. **(3)**

5. **Design of Chain Drives:** Design of roller chains, polygonal effect, power rating. **(3)**

6. **Design of levers:** design of foot lever, hand lever, bell crank lever **(3)**

7. **Design of Gear Drives:** Gear drives: Standard system of gear tooth and gear module, gear tooth failure, strength of gear tooth, terminology of spur, helical, bevel, worm and worm wheel, Design of spur, helical, straight bevel gears, worm and worm wheel. . **(5)**

8. **Design of springs:** Design of springs: helical compression, tension, tensional and leaf springs. **(3)**

9. **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. **(4)**

10. **Design of fasteners:** Riveted joints: Design of different types of riveted joints, boiler joints, lap joints, butt joints, eccentric loaded riveted joints, Welds: Design for various loading conditions in torsion, shear or direct load. **(4)**

11. **Design of Keys and Couplings:** Design of sunk keys under crushing and shearing, design of splines, design of sleeve and solid muff coupling, clamp or compression coupling, rigid and flexible flange coupling. **(3)**

RECOMMENDED BOOKS:

1. Joseph E. Shigley, Charles Russell Mischke, Richard Gordon Budynas, Mechanical Engineering Design, McGraw-Hill
2. Robert L. Norton, Machine Design; An Integrating Approach, Pearson Publication.
3. Robert C. Juvinall Fundamentals of machine component design, John Wiley Eastern
4. V.B Bhandari, Design of Machine elements, Tata Mc-Graw. Hill
5. Machine Design by R.S. Khurmi & J K Gupta

Note: Design Data book is allowed in Examination.