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

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

***The marks will be awarded on the basis of 04 weeks Institutional Practical Training conducted after 2nd Semester**

#Students will give presentations on the subject

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

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

#Students will give presentations on the subject

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

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

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

#Students will give presentations on the subject

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

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

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

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

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

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

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

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

List of Departmental Electives

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

List of Open Electives

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

Third Semester
Mechanical Engineering

BTME-18301 Theory of Machines-I

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

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

1. Basic Concept of machines

Link, Mechanism, Kinematic Pair and Kinematic Chain, Principles of Inversion, Inversion of a Four Bar Chain, Slider-Crank-Chain and Double Slider-Crank-Chain. Graphical and Analytical methods for finding: Displacement, Velocity, and Acceleration of mechanisms (including Corliolis Components). **(6)**

2. Lower and higher Pairs

Universal Joint, Calculation of maximum Torque, Steering Mechanisms including Ackerman and Davis approximate steering mechanism, Engine Indicator, Pentograph, Straight Line Mechanisms, Introduction to Higher Pairs With Examples. **(4)**

3. Belts, Ropes and Chains

Material & Types of belt, Flat and V-belts, Rope & Chain Drives, Idle Pulley, Intermediate or Counter Shaft Pulley, Angle and Right Angle Drive, Quarter Turn Drive, Velocity Ratio, Crowning of Pulley, Loose and fast pulley, stepped or cone pulleys, ratio of tension on tight and slack side of belts, Length of belt, Power transmitted by belts including consideration of Creep and Slip, Centrifugal Tensions and its effect on power transmission. **(6)**

4. Cams

Types of cams and follower, definitions of terms connected with cams. Displacement, velocity and acceleration diagrams for cam followers. Analytical and Graphical design of cam profiles with various motions (SHM, uniform velocity, uniform acceleration and retardation, cycloidal Motion). Analysis of follower motion for circular, convex and tangent cam profiles. **(5)**

5. Friction Devices

Concepts of friction and wear related to bearing and clutches. Types of brakes function of brakes. Braking of front and rear tyres of a vehicle. Determination of braking capacity, Types of dynamometers, (absorption, and transmission). **(6)**

6. Flywheels

Turning moment and crank effort diagrams for reciprocating machines' Fluctuations of speed, coefficient of fluctuation of speed and energy, Determination of mass and dimensions of flywheel used for engines and punching machines. **(3)**

7. Governors

Function, types and characteristics of governors. Watt, Porter and Proell governors. Hartnell and Willson-Hartnell spring loaded governors. Numerical problems related to these governors. Sensitivity, stability, isochronisms and hunting of governors. Governor effort and power, controlling force curve, effect of sleeve friction. **(8)**

Course Outcomes:

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

Suggested Readings / Books:

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

BTME-18302 Thermodynamics

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

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

1. Basic Concepts

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

2. First Law of Thermodynamics

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

3. Second Law of Thermodynamics

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

4. Gas Power Cycles and I.C. Engines

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

5. Steam Formation and Vapor Power Cycles

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

Course Outcomes:

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

Suggested Books:

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

BTME-18303 Strength of Materials-I

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

Course Objectives:

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

1. Simple, Compound Stresses and Strains
Stress and Strain and their types, Hook's law, longitudinal and lateral strain, Poisson's ratio, stress-strain diagram for ductile and brittle materials, extension of a bar due to without and with self-weight, bar of uniform strength, stress in a bar, elastic constants and their significance, relation between elastic constants, Young's modulus of elasticity, modulus of rigidity and bulk modulus. Temperature stress and strain calculation due to axial load and variation of temperature in single and compound bars. Two dimensional stress system, stress at a point on a plane, principal stresses and principal planes, Mohr's circle of stress ellipse of stress and their applications. Generalized Hook's law, principal stresses related to principal strains. **(8)**

2. Bending Moment (B.M.) and Shear Force (S.F.) Diagrams
S.F. and B.M. definitions; relation between load, shear force and bending moment; B.M. and S.F. diagrams for cantilevers, simply supported beams with or without overhangs, and calculation of maximum B.M. and S.F. and the point of contra flexure under the following loads:
a) Concentrated loads b) Uniformity distributed loads over the whole span or part of span
c) Combination of concentrated and uniformly distributed load d) Uniformly varying loads
e) Application of moments **(7)**

3. Bending Stresses in Beams
Assumptions in the simple bending theory; derivation of formula and its application to beams of rectangular, circular and channel, I and T- sections. Combined direct and bending stresses in aforementioned sections, composite/flitched beams. **(5)**

4. Torsion
Derivation of torsion equation and its assumptions and its application to the hollow and solid circular shafts. Torsional rigidity, combined torsion and bending of circular shafts; principal stress and maximum shear stresses under combined loading of bending and torsion. **(5)**

5. Columns and Struts
Introduction, failure of columns, Euler's formula, Rankine-Gordon's formula, Johnson's empirical formula for axially loaded columns and their applications. **(4)**

6. Slope and Deflection

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

a) Cantilevers

b) Simply supported beams with or without overhang

c) Under concentrated loads, uniformly distributed loads or combination of concentrated & uniformly distributed loads. **(7)**

Course Outcomes:

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

Suggested Books:

1. D.S. Bedi, Strength of Materials, Khanna Book Publishing Company.
2. E.P. Popov, Mechanics of Materials-(SI Version), Prentice Hall India.
3. R.S Lehri and A.S. Lehri, Strength of Materials, Kataria and Sons.
4. S.S.Rattan, Strength of Materials, Tata McGraw Hill.

BTME-18304 Materials Engineering

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

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

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

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

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

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

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

Course Outcomes:

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

4. Explain various components of phase diagrams and microstructure development

Suggested Books:

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

BTME-18305 Manufacturing Processes-I

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

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

1. Introduction

Classification of manufacturing processes, selection criteria for manufacturing processes, general trends in manufacturing. Introduction to additive manufacturing and rapid prototyping. (6)

2. Casting Processes

Introduction to metal casting. patterns: types, materials and allowances. Moulding materials: moulding sand compositions and properties, sand testing, types of moulds, moulding machines. Cores: function, types, core making process, core-prints, chaplets. Elements of gating system and risers and their design. Design considerations of castings. Melting furnaces, cupola furnace, charge calculations, induction furnaces. Casting processes: sand casting, shell mould casting, investment casting, permanent mould casting, full mould casting, vacuum casting, die casting, centrifugal casting, and continuous casting. Metallurgical considerations in casting, Solidification of metals and alloys, directional solidification, segregation, nucleation and grain growth, critical size of nucleus. Cleaning and finishing of castings. (12)

3. Welding Processes

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

(14)

4. Inspection and Testing

Casting defects, their causes and remedies. Welding defects, their causes and remedies. Destructive and non-destructive testing: visual inspection, x-ray radiography, magnetic particle inspection, dye penetrate test, ultrasonic inspection, eddy current testing, hardness testing, and micro hardness testing. (8)

Course Outcomes:

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

Suggested Readings / Books:

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

BTME-18306 Strength of Material lab

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

L T P
0 0 2

List of Experiments

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

Course Outcomes:

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

BTME-18307 Manufacturing Process Lab

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

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

Casting

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

Welding

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

Machining and Forming

1. To study constructional features of following machines through drawings/ sketches:
   a. Grinding machines (Surface, Cylindrical)
   b. Hydraulic Press
   c. Draw Bench
   d. Drawing and Extrusion Dies
   e. Rolling Mills
2. To grind single point and multipoint cutting tools on tool and cutter grinder.
3. To prepare job on Lathe involving specified tolerances; cutting of V- threads and square threads.
4. To prepare job on shaper involving plane surface.
5. Use of milling machines for generation of plane surfaces, spur gears and helical gears; use of end mill cutters.
6. To determine cutting forces with dynamometer for turning, drilling and milling operations.

Course Outcomes:

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

BTME-18308 Institutional (Workshop) Training

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

Fourth Semester
Mechanical Engineering

BTME-18401 Theory of Machines-II

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

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

1. Static force analysis
Concept of force and couple, free body diagram, condition of equilibrium, static equilibrium of mechanism, methods of static force analysis of simple mechanisms. Power transmission elements, considerations of frictional forces. **(5)**

2. Dynamic force analysis
Determination of forces and couples for a crank, inertia of reciprocating parts, dynamically equivalent system, analytical and graphical method, inertia force analysis of basic engine mechanism, torque required to overcome inertia and gravitational force of a four bar linkage. **(6)**

3. Balancing
Necessity of balancing, static and dynamic balancing, balancing of single and multiple rotating masses, partial unbalanced primary force in an engine, balancing of reciprocating masses, and condition of balance in multi cylinder in line V-engines , concept of direct and reverse crank, balancing of machines, rotors, reversible rotors. **(6)**

4. Gears:
Toothed gears, types of toothed gears and its terminology. Path of contact, arc of contact, conditions for correct gearing, forms of teeth, involutes and its variants, interference and methods of its removal. Calculation of minimum number of teeth on pinion/wheel for involute rack, helical, spiral, bevel and worm gears. Center distance for spiral gears and efficiency of spiral gears. **(6)**

5. Gear Trains
Types of gear trains, simple, compound and epicyclic gear trains, problems involving their applications, estimation of velocity ratio of worm and worm wheel. **(5)**

6. Gyroscopic motion and couples
Effect on supporting and holding structures of machines. stabilization of ships and planes, Gyroscopic effect on two and four wheeled vehicles and stone crusher. **(4)**

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

Course Outcomes:

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

Suggested Readings / Books:

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

BTME-18402 Applied Thermodynamics

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

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

1. Nozzles, Steam Turbines and Condensers

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

2. Thermodynamics of Compressors

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

3. Positive Displacement Air Compressors

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

4. Dynamic Compressors

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

5. Gas Turbines and Jet Propulsion

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

Course Outcomes:

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

Suggested Books:

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

BTME-18403 Strength of Materials-II

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

Course Objectives:
The course is designed to help undergraduate students to understand the concepts of strain energy, resilience, stress under impact loading; shear stress distribution in a beam of various cross sections; stress in curved cross sections; stresses in helical, spiral and leaf springs; stress and strain analysis of thin, thick cylinder and spheres subjected to internal pressure and various failure theories.

1. Strain Energy
Introduction to strain energy, energy of dilation and distortion. Resilience, stress due to suddenly applied loads. Castigliano's and Maxwell's theorem of reciprocal deflection. **(5)**

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

3. Springs
Open and closed coiled helical springs under the action of axial load and/or couple. Flat spiral springsderivation of formula for strain energy, maximum stress and rotation. Leaf spring deflection and bending stresses. **(5)**

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

5. Thick Cylinders
Derivation of Lame's equations, calculation of radial, longitudinal and hoop stresses and strains due to internal pressure in thick cylinders, compound cylinders, hub shrunk on solid shafts, shrinkage allowance and shrinkage stress. **(7)**

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

7. Shear stresses in Beams
Shear stress distribution in rectangular, circular, I, T and channel section; built up beams. Shear centre and its importance. **(4)**

8. Rotational Discs

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

Course Outcomes:

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

Suggested Books:

1. D.S. Bedi, Strength of Materials, Khanna Book Publishing Company.
2. E.P. Popov, Mechanics of Materials-(SI Version), Prentice Hall India.
3. R.S Lehri and A.S. Lehri, Strength of Materials, Kataria and Sons.
4. S.S.Rattan, Strength of Materials, Tata McGraw Hill.

BTME-18404 Fluid Mechanics

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

Course Objectives: This course is designed for the undergraduate mechanical engineering students to develop an understanding of the behaviour of fluids at rest or in motion and the subsequent effects of the fluids on the boundaries as the mechanical engineers has to deal with fluids in various applications. This course will also develop analytical abilities related to fluid flow. It is expected that students will be able to have conceptual understanding of fluids and their properties, apply the analytical tools to solve different types of problems related to fluid flow in pipes, design the experiments effectively and do the prototype studies of different types of machines and phenomenon.

1. Introduction: Concept of fluid; Difference between solids, liquids and gases; Concept of continuum; Ideal and real fluids; Fluid properties: Density, specific volume, specific weight, specific gravity, viscosity (dynamic and kinematic), Vapor pressure, compressibility, bulk modulus, Mach number, surface tension and capillarity; Newtonian and non-Newtonian fluids. **(4)**

2. Fluid Statics: Concept of static fluid pressure; Pascal's law and its engineering applications; Hydrostatic paradox; Metacentric height and its determination; Periodic time of oscillation; Pressure distribution in a liquid subjected to: (i) constant acceleration along horizontal, vertical and inclined direction (linear motion), (ii) constant rotation. **(5)**

3. Fluid Kinematics: Classification of fluid flows; Path line, streak line, streamline and timelines; Flow rate and discharge mean velocity; Derivation of continuity equation using the Lagrangian method in Cartesian coordinates; Rotational flows: rotation, vorticity and circulation; Stream function and velocity potential function, and relationship between them; Flow net. **(6)**

4. Fluid Dynamics: Derivation of Euler's equation of motion in Cartesian coordinates, Derivation of Bernoulli's equation (using principle of conservation of energy and equation of motion) and its applications to steady state ideal and real fluid flows; Representation of energy changes in fluid system (hydraulic and energy gradient lines); Impulse momentum equation; Kinetic energy and momentum correction factors; Flow along a curved streamline. **(6)**

5. Dimensional Analysis and Similitude: Need of dimensional analysis; Fundamental and derived units; Dimensions and dimensional homogeneity; Rayleigh's and Buckingham's π - method for dimensional analysis; Dimensionless numbers (Reynolds, Froudes, Euler, Mach, and Weber) and their significance; Need of similitude; Geometric, kinematic and dynamic similarity; Model and prototype studies; Similarity model laws. **(6)**

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

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

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

Course Outcomes:

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

Suggested Books:

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

BTME-18405 Manufacturing Processes-II

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

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

1. Machine Tools

Classification, description and operations, kinematic scheme of lathe, and lathe attachments. Shaping and planing machine: classification, description and operations, drive mechanisms. Milling machine: classification, description and operations, indexing devices, up milling and down milling. Drilling machine: classification, description and operations. Boring machine: classification, description and operations. Grinding machines: classification, description and operations, wheel selection, grinding wheel composition and nomenclature of grinding wheels, dressing and truing of grinding wheels. Broaching machine: classification, description and operations. Speed, feed and machining time calculations of all the above machines. Introduction to 3D printing. **(12)**

2. Metal Cutting

Introduction to machining processes, classification, Mechanics of chip formation process, concept of shear angle, chip contraction and cutting forces in metal cutting, Merchant theory, tool wear, tool life, machinability. Numerical problems based on above mentioned topics, Fundamentals of measurement of cutting forces and chip tool interface temperature. Cutting tools: types, geometry of single point cutting tool, twist drill and milling cutter, tool signature. Cutting tool materials: high carbon steels, alloy carbon steels, high speed steel, cast alloys, cemented carbides, ceramics and diamonds, and CBN. Selection of machining parameters. Coolants and lubricants: classification, purpose, function and properties. **(12)**

3. Metal Forming

Introduction and classification. Rolling process: introduction, classification, rolling mills, products of rolling, rolling defects and remedies. Forging: open and closed die forging, forging operations, hammer forging, press forging and drop forging, forging defects, their causes and remedies. Extrusion: classification, equipment, defects and remedies. Drawing: drawing of rods, wires and tubes, draw benches, drawing defects and remedies. Sheet metal forming operations: piercing, blanking, embossing, squeezing, coining, bending, drawing and deep drawing, and spinning. Punch and die set up. Press working: press types, operations, press tools, progressive

and combination dies. Process variables and simple numerical problems related to load calculation in Rolling, Forging, Extrusion, Drawing and Sheet metal forming. High velocity forming of metals: introduction, electro-hydraulic forming, mechanical high velocity forming, magnetic pulse forming and explosive forming. Powder Metallurgy: Introduction, advantages, limitations, and applications methods of producing metal powders, briquetting and sintering. **(16)**

Course Outcomes:

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

Suggested Readings / Books:

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

BTME-18406 Applied Thermodynamics Lab

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

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

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

3. To determination of dryness fraction of steam and estimation of brake power, Rankine efficiency, relative efficiency, generator efficiency and overall efficiency of an impulse steam turbine.

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

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

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

Course Outcomes:

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

BTME-18407 Theory of Machines Lab

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

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

List of experiments

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

Course Outcomes:

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