3rd SEMESTER

Third Semester **Contact Hours: 34 Hrs.**

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

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

Applied Thermodynamics-I (BTME 304)

Course Objectives :

1. This course is designed for comprehensive study of combustion and thermal aspects in internal combustion engines, steam power plants and its allied components.
2. This will enable the students to solve various problems and evaluate theoretically the performance of various components involved in steam power plants and internal combustion engines.

Course Outcomes:

After completion of course, a student is able to

1. Understand the type of IC Engines and various performance parameters.
2. Understand and analyze the combustion phenomenon in boilers and I.C. engines.
3. Use steam table and Mollier charts to solve various vapour power cycle problems.
4. Understand the constructional features and working of major components of steam power plant and evaluate their performance with the help of steam tables and velocity triangle diagram in case of turbines.

COURSE CONTENT:

Unit –I

Combustion: Combustion Equations **(**Stoichiometric and non- Stoichiometric**).** Combustion problems in Boilers and IC engines/Calculations of air fuel ratio, Analysis of products of combustion, Conversion of volumetric analysis into gravimetric analysis and vice-versa, Actual weight of air supplied, Use of mols, for solution of combustion problems, Heat of formation, Enthalpy of formation, Enthalpy of reaction, Adiabatic flame temperature.

Unit –II

IC Engines Introduction: Actual Engine Indicator diagrams and valve-timing diagrams for two stroke and four stroke S.I. and C.I. Engines; **Construction and Working Principle** of Wankel rotary engine; Principle of simple carburator, Injection systems in Diesel and Petrol Engines(Direct Injection, MPFI in SI and CI Engines, respectively). Essential requirements for Petrol and Diesel Fuels. Theory of combustion in SI and CI Engines; Various stages of combustion;

Pressuretime/ crank - Angle diagrams; Various phenomenon such as turbulence, squish and swirl, dissociation, pre-ignition/auto- ignition, and after burning etc.; Theory of knocking (ie,. detonation) in SI and CI Engines; Effect of engine variables on the Delay Period in SI and CI engines; Effect of various parameters on knock in SI and CI Engines; Methods employed to reduce knock in SI and CI Engines; Octane and Cetane rating of fuels; Knockmeter; Dopes and inhibitors; Performance curves/maps of SI and CI Engines; Effect of ***compression ratio*** and ***air-fuel ratio*** on power and efficiency of engine; Variation of engine power with altitude; Supercharging and turbo charging of SI and CI Engines; Advantages and applications of supercharging; Emissions from SI and CI Engines and methods to reduce/control them. Logarithmic plotting of PV-diagrams. High speed Engine Indicators.

Unit –III

Properties of Steam

Pure substance; Steam and its formation at constant pressure: wet, dry, saturated and super-heated steam; Sensible heat(enthalpy), latent heat and total heat (enthalpy) of steam; dryness fraction and its

determination; degree of superheat and degree of sub-cool; Entropy and internal energy of steam; Use of Steam Tables and Mollier Chart; Basic thermodynamic processes with steam (isochoric, isobaric, isothermal, isentropic and adiabatic process) and their representation on **T-S** Chart and Mollier Charts(h-s diagrams). Significance of Mollier Charts.

Unit –IV

Steam Generators - Definition: Classification and Applications of Steam Generators; Working and constructional details of fire-tube and water-tube boilers: (Cochran, Lancashire, Babcock and Wilcox

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

Unit –V

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

Unit –VI

Steam Nozzles - Definition, types and utility of nozzles; Flow of steam through nozzles; Condition for

maximum discharge through nozzle; Critical pressure ratio, its significance and its effect on

discharge; Area of **throat** and at **exit** for maximum discharge; Effect of friction; Nozzle efficiency;

Convergent and convergent-divergent nozzles; Calculation of Nozzle dimensions (length and diameters of throat and exit); Supersaturated (or metastable) flow through nozzle.

Unit –VII

Steam Turbines Introduction; Classification; Impulse versus Reaction turbines. **Simple impulse turbine**: pressure and velocity variation, Velocity diagrams/triangles; Combined velocity diagram /triangle and calculations for force, axial thrust, work, power, blade efficiency, stage efficiency, maximum work and maximum efficiency, effect of blade friction on velocity diagram, effect of speed ratio on blade efficiency, condition for axial discharge;

Unit –VIII

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

Unit –IX

Impulse-Reaction Turbine: pressure and velocity variation, velocity diagrams/triangles, Degree of reaction, combined velocity diagram/triangle and calculations for force, axial thrust, work, power, blade efficiency, stage efficiency, overall efficiency and relative efficiency, maximum work and maximum efficiency; Calculations of blade height; **Multistaging**: Overall efficiency and relative efficiency; Reheating, Reheat factor and condition curve; Losses in steam turbines;

Back pressure and extraction turbines; Co-generation; Economic assessment; Governing of steam turbines.

Unit –X

Steam Condensers Function; Elements of condensing unit; Types of condensers; Dalton's law of partial pressures applied to the condenser problems; Condenser and vacuum efficiencies; Cooling water calculations; Effect of air leakage; Method to check and prevent air infiltration; Description of air pump and calculation of its capacity; **Cooling towers:** function, types and their operation.

Books:

1. R. Yadav, Sanjay and Rajay, Applied Thermodynamics, Central Publishing House.
2. J.S. Rajadurai, Thermodynamics and Thermal Engineering, New Age International (P) Ltd. Publishers.
3. D.S. Kumar and V.P. Vasandani, Heat Engineering, Metropolitan Book Co. Pvt. Ltd.
4. V. Ganeshan, Internal Combustion Engines, Tata McGRaw Hill.
5. R K Rajput, Thermal Engineering, Laxmi Publication.

Beyond the curriculum topics: -------

Video Lectures: **http://nptel.ac.in/courses/112103016/**
http://nptel.ac.in/courses/112105123/20

BTME-305 MANUFACTURING PROCESS –I

Course Objective/s

This course is designed to provide students with an overview of a wide variety of manufacturing processes for processing of engineering materials and their manufacturability.

Course Outcome/s (CO):

1. The students shall have the understanding of general trends in manufacturing & selection criteria for manufacturing processes.
2. Upon completion of the course, the students shall have the ability to understand the importance of the casting manufacturing process.
3. Upon completion of the course, the students shall have the ability to understand the importance of the Welding manufacturing process.
4. Students shall have the ability to select a suitable metal casting and metal joining processes to fabricate an engineering product.
5. Students shall learn about the different Inspection and non destructive testing processes
6. Student shall have the ability to select a suitable Inspection & non destructive testing processes to locate the surface as well as the internal defects in casted and welded components.

COURSE CONTENT:

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

Unit –II Casting Processes:

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

Unit –III Welding Processes:

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

Unit –IV Inspection and Testing:

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

Text Book

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.

Reference Book

1. Serope Kalpakjian and Steven R. Schmid, Manufacturing Engineering and Technology, Pearson Publishers.
2. Heine, R.W. C.R. Loper and P.C. Rosenthal, Principles of metal casting Mc Graw Hill New York-

THEORY OF MACHINES-I (BTME-302)

COURSE Objectives & OUTCOMES:

Course Objective/s:

1. Understand the basic concepts of machines and mechanisms for compute the velocity and acceleration diagrams of all basic mechanisms.

2. Derive the relationship between tension on tight and slack sides of belts and HP

Transmitted by the belt and Understand the types of drives such as: belts, ropes and chains

3. Understand the types of cam & follower.

4. Applied different formulae to compute problems on brakes and dynamometers.

5. Understand the functions, types and characteristics of governors and Apply the theory of governors to solve numerical problems

Course Outcome/s:

Students who pass the course will be able to;

I. Determine the kinematic chain and mobility, and perform the kinematic analysis of a given mechanism.
II. The students will be able to determine velocities & accelerations of various planar mechanisms.
III. Apply the fundamental principles of statics and dynamics to machinery
IV. Be able to design linkage, cam and governor for a given motion or a given input/output motion or force relationship.
V. Students will demonstrate the dynamics of flywheel and their motion
VI. Ability to conduct a complete (translational and rotational) velocity, acceleration analysis of the mechanism and to understand steering mechanism and the importance of universal (Hooke's) joint
VII. At the end of this unit, the students should be able to understand: Uses and advantages of belt drives Types and their nomenclature, Relationship between belt tensions commonly used design parameters.

COURSE CONTENT:

1. Basic Concept of machines: link mechanism kinematic pair and chain, principles of inversion, inversion of a four bar chain, slider-crank-chain, double slider-crank chain and their inversions, kinematic pairs, Graphical (relative velocity vector and instantaneous center methods) and Analytical methods for finding: Displacement, velocity, and acceleration of mechanisms (including Corliolis components).

2. Lower Pairs: Universal joint, calculation of maximum torque, steering mechanisms including Ackerman and Davis approximate steering mechanism, engine indicator, Pentograph, Straight line mechanisms.

3. Belts, Ropes and Chains : Material, types of drives, idle pulley, intermediate or counter shaft pulley, angle and right angle drive, quarter turn drive, velocity ratio, crowning shaft pulley, loose and fast pulley, stepped or cone pulleys, ratio of tension on tight and slack sided of belts, HP transmitted by belts including consideration of creep and slip, centrifugal tensions and its effect on HP transmitted. Use of gravity,idle, flat, V-belts and rope materials. Length of belt, rope and chain drives, type and cone type.

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). Analysis of follower motion for circular convex, tangent cam profiles. Calculation of pressure angle.

5. Friction Devices: Concepts of frictions and wear related to bearing and clutches. Types of brakes, principle of function of brakes of various types. Braking of front and rear tyres of a vehicle, Problems to determine braking capacity, Types of dynamometers,(absorption, transmission).

6. Flywheels: Turning moment and crank effort diagrams for reciprocating machines Fluctuations of speed, coefficient of fluctuation of speed and energy, Determination of flywheel mass and dimensions for engines and Punching Machines.

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

Recommended Text Book:

TEXT/ REFERENCE BOOKS:

T/R	BOOK TITLE/ AUTHORS/ PUBLICATION
T1	S. S. Rattan, Theory of Machines, Tata McGraw Hill, New Delhi
T2	R.S,Khurmi,Theory of Machines,s.chand
R1	Thomas Beven, Theory of Machines, Longman's Green & Co., London
R2	Shigley , Theory of Machines, Mcgraw Hill , New York

List of Videos and Internet Materials Referred

WEB SOURCE REFERENCES:

1	www.mccormick.northwestern.edu
2	https://india.oup.com/orcs/9780199454167/
3	http://studymech.com/resources/resources.html

Beyond the curriculum topics

- Simulations of Different types of Mechanisms

MOOCs

- http://nptel.ac.in/courses/112104121/1 (Kinematics of Machines)
- https://www.mooc-list.com/tags/kinematics (Kinematics)

MACHINE DRAWING (BTME-303)

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.

The student shall be able to understand the drawings of mechanical components and their assemblies along with their utility for design of components.

Course Outcomes

After the completion of the course the student will be able to:

CO 1: Analyze and draw the drawings of mechanical components.

CO 2: Assemble and disassemble the various mechanical systems using drafting.

CO 3: Analyze complex design systems related to mechanical engineering.

CO 4: Function effectively as member to work as teams.

Syllabus

Unit–I

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

Unit–II

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

Unit –III

Assembly and Disassembly:

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

b) Knuckle and cotter joints

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

expansion joint

d) IC Engine Parts: Piston, connecting rod

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

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

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

TEXT/ REFERENCE BOOKS:

T/R	**BOOK TITLE/ AUTHORS/ PUBLICATION**
T1	P.S. Gill, Machine Drawing, BD Kataria and Sons.
T1	Ajit Singh, Machine Drawing (including Auto CAD), Tata McGraw Hill
R1	R. K. Dhawan, A Text Book of Machine Drawing, S. Chand and Co. Ltd
R2	K Narayana and Kannaiah, Machine Drawing New Age International Publishers
R3	N.D. Bhatt, Machine Drawing, Charotar publications

SOM-I (BTME-301)

Btech ME- 3rd Sem

Course Objectives

The course is designed to understand:

a) Basic concepts of stress, strain and their variations due to different type of loading.
b) The concept of Mechanical properties, Poisson's ratio, bulk modulus, elastic modulus, modulus of rigidity, combined stress and strain.
c) Principal stress, principal plane.
d) Bending moment and shear force in beam under various loading conditions.
e) Understanding of torsional shear stress in solid and hollow shaft; principal and maximum shear stress in a circular shaft subjected to combined stresses.
f) Stresses in struts and columns subjected to axial load.
g) Bending stresses in Beams
h) Slope and deflection under different loading and supporting conditions.

Course Outcomes(COs)

After the study of this course, a student is expected to analyze:

CO-1- Different stresses, strains in simple mechanical components.
CO-2- Shear force and Bending Moments in beams under various loading conditions
CO-3- Bending stresses in beams
CO-4- Torsional stresses in solid and hollow shafts
CO-5- Buckling loads for struts and columns
CO-6- Slope and deflection of beams under various loading conditions

Course Contents

Unit –I

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

Unit –II

Bending Moment (B.M) and Shear Force (S.F) Diagrams: S.F and B.M definitions; relation between load, shear force and bending moment; B.M and S.F diagrams for cantilevers, simply

supported beams with or without overhangs, and calculation of maximum B.M and S.F and the point of contra flexure under the following loads:

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

Unit –III
Bending Stresses In Beams: Assumptions in the simple bending theory; derivation of formula and
its application to beams of rectangular, circular and channel, I and T- sections. Combined direct and
bending stresses in afore-mentioned sections, composite / flitched beams.
Unit –IV
Torsion: Derivation of torsion equation and its assumptions and its application to the hollow and solid circular shafts. Torsional rigidity, combined torsion and bending of circular shafts; principal
stress and maximum shear stresses under combined loading of bending and torsion.
Unit –V
Columns and struts: Introduction, failure of columns, Euler's formula, Rankine-Gordon's formula,
Johnson's empirical formula for axially loaded columns and their applications.
Unit –VI
Slope and deflection: Relationship between moment, slope and deflection; method of integration,
Macaulay's method, moment area method and use of these methods to calculate slope and deflection for the following:
a) Cantilevers
b) Simply supported beams with or without overhang
c) Under concentrated loads, uniformly distributed loads or combination of concentrated & uniformly distributed loads.

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List of Books Referred

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

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/ DESIGN:

S.No.	Description	PO Mapping
1	Hands on experience on advanced software of stress analysis	1-4

MOOCs

1. Mechanics of Materials-I
   https://www.coursera.org/learn/mechanics-1

2. Strength of Materials
   https://onlinecourses.nptel.ac.in/noc17_ce22/preview

EMM BTME 306

Course objectives:-

1. To develop fundamental concepts of crystallography, phase transformation and heat treatment processes.
2. The students will learn the atomic structure of metals, imperfections, diffusion mechanisms and theories of plastic deformation.
3. Understanding of equilibrium diagrams, time-temperature transformation curves and heat treatment processes.

Course Outcomes

CO1 Understand the concepts of crystal structure, microstructure and deformation

CO2 Understand different types of phase diagrams.

CO3 Understand equilibrium diagrams which are useful for design and control of heat treating processes.

Unit –I

Crystallography: Atomic structure of metals, atomic bonding in solids, crystal structures, crystal lattice of body centered cubic, face centered cubic, closed packed hexagonal; crystalline and non crystalline materials; crystallographic notation of atomic planes; polymorphism and allotropy; imperfection in solids: theoretical yield strength, point defects, line defects and dislocations, interfacial defects, bulk or volume defects. Diffusion: diffusion mechanisms, steady-state and nonsteady- state diffusion, factors affecting diffusion. Theories of plastic deformation, recovery,
re-crystallization.

Unit –II

Phase Transformation: General principles of phase transformation in alloys, phase rule and equilibrium diagrams, Equilibrium diagrams of Binary systems. Iron carbon equilibrium diagram and various phase transformations. Time temperature transformation curves (TTT curves): fundamentals, construction and applications.

Unit –III

Heat Treatment: Principles and applications. Processes viz. annealing, normalizing, hardening, tempering. Surface hardening of steels: Principles of induction and oxyacetylene flame hardening. Procedure for carburising, nitriding and cyaniding. Harden-ability: determination of harden-ability. Jominy end-quench test. Defects due to heat treatment and their remedies; effects produced by alloying elements. Composition of alloy steels.

Unit –IV

Ferrous Metals and Their Alloys: Introduction, classification, composition of alloys, effect of alloying elements (Si, Mn, Ni, Cr, Mo, W, Al) on the structures and properties of steel.

Suggested Readings / Books:

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

4TH SEMESTER

Fourth Semester **Contact Hours: 32 Hrs.**

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

BTME 401 Strength of Materials-II

Course Objectives:

1. To provide the basic concepts and principles of strength of materials.

2. To give an ability to calculate stresses and deformations of objects under external loadings.

3. To give an ability to apply the knowledge of strength of materials on engineering applications and design problems.

Course Outcomes

After the completion of the course the student will be able to:

CO1. Understand the concepts of strain energy and apply the various failure theories for the design of mechanical members.

CO2. Calculate the stresses and strains in spring members subjected to various loadings.

CO3. Calculate the stresses and strains associated with thin and thick walled cylindrical pressure and spherical vessels.

CO4. Determine the stresses and strains in straight and curved beam members subjected to combined loading.

CO5. Design the mechanical members for rotational stresses.

Syllabus

BTME 401 Strength of Materials-II

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

Unit –II
Theories of failure: Maximum principal stress theory, maximum shear stress theory, maximum principal strain theory, total strain energy theory, shear strain energy theory. Graphical representation and derivation of equation for these theories and their application to problems related
to two dimensional stress systems.

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

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

Unit –V
Thick cylinders: Derivation of Lame's equations, calculation of radial, longitudinal and hoop stresses and strains due to internal pressure in thick cylinders, compound cylinders, hub shrunk on solid shafts, shrinkage allowance and shrinkage stress.

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

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

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

TEXT/ REFERENCE BOOKS:

T/R	BOOK TITLE/ AUTHORS/ PUBLICATION
T1	Dr. Sadhu Singh, Strength of Materials, Khanna Publishers Ltd.
T2	R.K.Rajput, Strength of materials, S.Chand Publishing Company.
R1	R.S Lehri and A.S. Lehri, Strength of materials, vol. 2, S. K. Kataria and Sons.
R2	D.S. Bedi, Strength of materials, Khanna book publishing company.
R3	S.S.Rattan, Strength of materials, Tata McGraw Hills.
R4	Timoshenko and Gere, Mechanics of materials, CBS Publishers.
R5	G.H. Ryder, Strength of materials, Macmillan India Ltd.

List of Videos and internet material referred

http://nptel.ac.in/courses/105105108/39

THEORY OF MACHINES-II BTME-402

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.

Course Outcomes

After the completion of the course the student will be able to:

CO1 – Analyse the force system on static and dynamic mechanisms

CO2 – Perform balancing of rotating and reciprocating parts.

CO3 – Understand gear terminology and solve the problems relating to gear trains.

CO4 –Analyse the gyroscopic effect on moving objects.

Syllabus

Unit –I
Static force analysis:, Concept of force and couple, free body diagram, condition of equilibrium,

static equilibrium of mechanism, methods of static force analysis of simple mechanisms. Power transmission elements, considerations of frictional forces

Unit –II

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

Unit –III

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

Unit –IV

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

Unit –V

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

Unit –VI

Gyroscopic motion and couples: Effect on supporting and holding structures of machines. stabilization of ships and planes, Gyroscopic effect on two and four wheeled vehicles and stone crusher.

Unit –VII

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

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List of Books Referrred

S.S. Rattan, Theory of Machines, Tata Mc. Graw Hill.

TEXT/ REFERENCE BOOKS:

T/R	BOOK TITLE/ AUTHORS/ PUBLICATION
R1	John, Gordon, and Joseph, Theory of Machines and Mechanisms, Oxford University Press.
R2	Hams Crone and Roggers, Theory of Machines.
T1	R.S. Khurmi, Theory of Machines, S. Chand
R3	Shigley, Theory of Machines, Mc Graw Hill.

T2	V.P. Singh, Theory of Machines, Dhanpat Rai and Sons.
T3	□□V.P. Singh, Theory of Machines, Dhanpat Rai and Sons.

List of Videos and internet material referred

(Pls specify complete hyperlink)

- **nptel.ac.in**
- home.iitk.ac.in/~anupams/me352a_2015_course_folder/M_09g1.**ppt**x
- **Gear Cutting:**
  - **http://www.youtube.com/watch?v=fps0OR1eF_s&feature=related**
  - **http://www.youtube.com/watch?v=xF9CjluRFJ4&feature=related**

MOOCs

1. **Kinematics of machines**

   http://nptel.ac.in/courses/112104121/1

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/ DESIGN:

S.No.	Description	PO Mapping
1	Design and manufacturing of gears	PO1-4
2	Application of gear trains in automobiles	PO 1-4

FLUID MECHANICS-I

(BTME-403)

Course Objectives:

After the completion of the course the student will be able to:

1. Conceptual understanding of fluids and their properties.

2. Understanding of fluid statistics, fluid kinematics and fluid dynamics.

3. Understand the concepts of rotational vs. irrotational flows; stream functions, velocity potentials. Laplace equation and its relation to elementary plane flows of inviscid fluids: sinks, sources and vortex flows.

4. Determine flow rates, pressure changes, minor and major head losses for viscous flows through pipes and blowers in such systems.

5. Basic knowledge of dimensional analysis and similitude.

6. Understanding of laminar and turbulent flows, and flow measurement.

Course Outcomes:

Students who pass the course will be able to;

CO1. Understand the basic principles of fluid mechanics
CO2. Analyze fluid flow problems with the application of the momentum and energy equations
CO3. Apply the fundamental principles of statics and dynamics to Fluid machinery
CO4. Ability to solve pipe flow network problems
CO5. Analyze pipe flows as well as fluid machinery

FLUID MECHANICS-I

(BTME-403)

1. **Fluid and their properties**: Concept of fluid, difference between solids, liquids and gases; ideal and real fluids; capillarity, vapour pressure, compressibility and bulk modulus; Newtonian and non- Newtonian fluids.

2. **Fluid Statics:** Concept of pressure, Pascal's law and its engineering applications, Hydrostatic paradox. Action of fluid pressure on a plane (horizontal, vertical and inclined) submerged surface, resultant force and center of pressure, force on a curved surface due to hydrostatic pressure.Buoyancy and flotation, stability of floating and submerged bodies, metacentric height and its determination, periodic time of oscillation, pressure distribution in a liquid subjected to constant horizontal/ vertical acceleration, rotation of liquid in a cylindrical container.

3. **Fluid Kinematics:** Classification of fluid flows, velocity and acceleration of fluid particle, local and convective acceleration, normal and tangential acceleration, streamline, path line and streak line, flow rate and discharge mean velocity, continuity equation in Cartesian and cylindrical, polar coordinates. Rotational flows, rotation velocity and circulation, stream and velocity potential functions, flow net.

4. **Fluid Dynamics:** Euler's equation, Bernoulli's equation and steady flow energy equation; representation of energy changes in fluid system, impulse momentum equation, kinetic energy and momentum correction factors, flow along a curved streamline, free and forced vortex motions.

5. **Dimensional Analysis and Similitude:** Fundamental and derived units and dimensions, dimensional homogeneity. Rayleigh's and Buckingham's Pi method for dimensional analysis. Dimensionless numbers and their significance, geometric, kinematic and dynamic similarity, model studies.

6. **Internal Flow:** Laminar and Turbulent Flows: Flow regimes and Reylods number, critical velocity and critical Reynolds number, laminar flow in circular cross- section pipes. Turbulent flows and flow losses in pipes, Darcy equation, minor head losses in pipes and pipe fittings, hydraulic and energy gradient lines.

7. **Flow Measurement:** Manometers, pitot tubes, venturi meter and orifice meters, orifice, mouthpieces, notches and weirs, rotameter.

TEXT/ REFERENCE BOOKS:

T/R	BOOK TITLE/ AUTHORS/ PUBLICATION
T1	Fluid Mechanics and Fluid Power Engineering by D.S. Kumar : S.K. Kataria and Sons Publishers.
T2	Mechanics of Fluids by Massey BS; Van Nostrand Reinhold Co.
T3	Fluid Mechanics by Streets VL and Wylie EB; Mcgraw Hill Book Co.

List of Videos and Internet Materials Referred

WEB SOURCE REFERENCES:

1	www.mccormick.northwestern.edu
2	https://india.oup.com/orcs/9780199454167/
3	http://studymech.com/resources/resources.html

Beyond the curriculum topics

- Awareness of G-suit

MOOCs

- http://nptel.ac.in/courses/112105171/1 (Fluid Mechanics)
- http://www.nptel.ac.in/courses/112104118/ui/Course_home-3.htm (Fluid Kinematics)

MANUFACTURING PROCESSES –II (BTME 405)

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.

Course Outcomes:

- 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.
- Students will be able to select the manufacturing process according to the design and manufacturing ability of the metal.

Course Contents:

Unit –I

Metal Forming:

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

Unit –II

Metal Cutting :

Introduction to machining processes, classification, Mechanics of chip formation process, concept of shear angle, chip contraction and cutting forces in metal cutting, Merchant theory, tool wear, tool life,

machinability. Numerical problems based on above mentioned topics, Fundamentals of measurement of cutting forces and chip tool interface temperature. Cutting tools : types,geometry of single point cutting tool, twist drill and milling cutter, tool signature.Cutting tool materials: high carbon steels, alloy carbon steels, high speed steel, cast alloys, cemented carbides, ceramics and diamonds, and CBN. Selection of machining parameters. Coolants and lubricants: classification, purpose, function and properties.

Unit III Machine Tools Lathe: classification, description and operations, kinematic scheme of lathe, and lathe attachments. Shaping and planing machine: classification, description and operations, drive mechanisms. Milling machine: classification, description and operations, indexing devices, up milling and down milling. Drilling machine: classification, description and operations. Boring machine: classification, description and operations. Grinding machines:classification, description and operations,wheel selection, grinding wheel composition and nomenclature of grinding wheels, dressing and truing of grinding wheels. Broaching machine:classification, descri

ption and operations.Speed, feed and machining time calculations of all the above machines.

SUGGESTED READINGS / BOOKS:

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

5TH SEMESTER

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

Total Contact Hours = 33

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

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

MMM(BTME-503)

Course Objectives

The aims of this course are:

1. To make the students articulate and restate the principles and mechanisms of measurement of different entities.
2. To exemplify techniques of utilizing the mechanical/electrical and/or electronic devices for measurement purposes and formulate the ways of enhancing their adaptability.
3. To develop the student's familiarity and competence in analyzing, calculating and designing the equipments for measurements of force/pressure/stress/temperature/flow etc.
4. To enhance the student's ability to apply system analysis and problem solving skills in various unwarranted situations that may arise in the field of measurements.

Course Outcomes

After successful completion of this course the student must be able to:

1. Define the basic fundamentals of any measuring device/instrument/machine.
2. Recognize and Reproduce various situations leading to variation in input parameters in the electrical circuits.
3. Sketch and explain the constructional features and the importance/function of the parts that constitute a measurement system.
4. Calculate the resulting effect on the output by varying the parameters at the input of a measuring system.
5. Analyze and solve the problems like unintentional variation in output/Noise/Vibrations etc.
6. Evaluate the results of varying input parameters and analyze the pros and cons of each variation.

7. Predict the effect of each change in input parameter and thereby suggest an optimum solution to the problem limiting the value of errors within the specified limits.

Course Syllabus: MMM

General Concepts

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

Static and Dynamic Characteristics of Instruments

Range and span, accuracy and precision, calibration, hysteresis and dead zone, sensitivity and linearity, threshold and resolution; speed of response, lag, fidelity and dynamic error, dead time and dead zone.

Zero, first and second order systems and their response to step, ramp and sinusoidal input signals.

Errors in Measurement

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

Metrology

Line, end and wavelength standards; linear measurements - vernier scale and micrometer, vernier height gauge and depth guage; comparators - their types, relative merits and limitations; Angular measurements - sine bar, clinometer, angle guage; concept and measurement of straightness and flatness by interferometry; surface roughness - specifications and measurement by Talysurf, Measurement of major diameter, minor diameter, effective diameter, pitch, angle and form of threads for internal and external threads; measurement of tooth thickness, pitch and checking of profile for spur gears.

Functional Elements

Review of electro-mechanical sensors and transducers - variable resistance, inductance and capacitive pick ups, photo cells and piezo-electric transducers and application of

these elements for measurement of position / displacement, speed /velocity / acceleration, force and liquid level. Resistance strain guages, guage factor, bonded and unbonded guages, surface preparation and bonding technique signal conditioning and bridge circuits, temperature compensation, application of strain guages for direct, bending and torsional loads. Introduction to amplifying, transmitting and terminating devices.

Pressure and Flow Measurement

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

Temperature Measurement

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

Speed, Force, Torque and Shaft Power Measurement

Mechanical tachometers, vibration reed tachometer and stroboscope; proving ring, hydraulic and pneumatic load cells, torque on rotating shafts; Absorption, transmission and driving dynamo meters.

Text and Reference books

1. Mechanical Measurements and Instrumentation
   R K Rajput
   S K Kataria & Sons Publishers

2. Mechanical Measurements & Control
   D.S. Kumar
   Metropolitan Book Co. (P) Ltd

3. Course In Mechanical Measurements And Instrumentation
   A K Sawhney & Puneet Sawhney
   Dhanpat Rai Publications
4. Measurement System

Doebelin
Tata McGraw-Hill Education

5. Metrology and Measurement
   Bewoor & Kulkarni
   McGraw Hill Publications

6. Instrumentation and Control Systems
   Raju & Reddy
   McGraw Hill Publication

Topics Beyond Curriculum

1. Signal Amplification and Filtering
2. International Practical Temperature Scale
3. Smart Sensors for Mechanical Measurements
4. Control Systems

Videos/Web Sources

1. http://nptel.ac.in/courses/112106138/
2. http://www.nptel.ac.in/courses/112106139/
3. www.youtube.com/playlist?list=PL522E677B167D6CB5
4. freevideolectures.com › Mechanical › IIT Madras
5. https://www.wiziq.com/online-tests/39-mechanical-measurements-and-instrumentation
6. https://www.tcyonline.com/tests/principles-of-mechanical-measurements-10

AUTOMOBILE ENGINEERING (BTME-505)

Course Objectives

The course is designed to understand:

i) The Basic Construction of Automobile
j) Environment Implications of Automobile
k) Understand various mechanisms and systems like Fuel Supply, Lubrication, Cooling System, Braking, Transmission, Ignition, Electric, Steering Systems Etc.
l) The Probable causes of Failure & Remedial Measures in different systems of Automobile

Course Outcomes

After the study of this course, a student will be able to:

CO 1- Understand the basic anatomy of automobile.
CO 2- Understand the Engine Performance and emission control mechanisms.
CO 3- Explain the working of various systems of automobile.
CO 4 - Perform Trouble shooting and rectification of automobile.

Syllabus

1. Introduction

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

2. Power Unit

Power requirements - motion resistance and power loss, tractive effort and vehicle performance curves; selection of power unit and engine performance characteristics; pollution due to vehicle emission and exhaust emission control system, silencers, types of pistons and rings

3. Fuel Supply System

Air cleaner and fuel pumps; Air fuel requirements and carburation; constructional details of Carter carburetors and fuel injection systems; MPFi (Petrol), Diesel fuel system - cleaning, injection pump, injector and nozzles, Common Rail fuel supply system

4. Lubrication and Cooling Systems

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

5. Chassis and Suspension

Loads on the frame, considerations of strength and stiffness, engine mounting, independent suspension systems (Mac Pherson, Trailing Links, Wishbone), shock absorbers and stabilizers; wheels and tyres, tyre wear types, constructional details of plies

6. Transmission system

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

7. Steering System

Requirement and steering geometry; castor action, camber and king pin angle, toe-in of front wheels, steering linkages and steering gears; wheel alignment; power steering, Ball re-circulating mechanism

8. Braking System

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

9. Electric System

Classification, Introduction to Conventional and transistorized ignition systems; Charging, capacity ratings and battery testing; starter motor and drive arrangements: voltage and current regulation

10. Maintenance

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

List of Books Referrred

TEXT/ REFERENCE BOOKS:

T/R	BOOK TITLE/ AUTHORS/ PUBLICATION
R1	W.H Crouse, Automotive mechanics, McGraw Hill
R2	J. Heitner, Automotive Mechanics, East West Press
R3	J. Webster, Auto Mechanics, Glencoe Publishing Co
T1	Kirpal Singh, Automobile Engineering Vol. I and II, Standard Publishers
T2	P.S Gill, Automobile Engineering, S.K Kataria

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/ DESIGN:

S.No.	Description	PO Mapping
1	Specifications of latest automotive vehicles	PO1-3

Video lectures

Video lectures presented on following Topics

Air Filter, Carburetor, CRDI, Electronic Fuel Injection, Pressure Lubrication

MOOCs

1. Automotive Engineering
   https://www.openeducationeuropa.eu/en/category/freetags/automotive-engineering
2. Vehicle Dynamics-I
   https://iversity.org/en/courses/vehicle-dynamics-i-accelerating-and-braking

DOM -1 BTME 501

Course objectives

1. To develop an ability to identify, formulate, and solve engineering problems.
2. To develop an ability to design a system, component, or process to meet desired needs within realistic constraints.
3. To develop an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
4. To understand the loading on machine elements and allowable stresses.
5. Concept of yielding and fracture.
6. Practice professional and ethical responsibility, and, be aware of the impact of their designs on human-kind and the environment.

Course Out comes:-

CO1 Understand the customers' need, formulate the problem and draw the design specifications.

CO2 Understand component behaviors subjected to loads and identify the failure criteria.

CO3 Analyze the stresses and strains induced in a machine element.

CO4 Design a machine component using theories of failure.

CO5 Design keys, cotters, couplings and joints including riveted, bolted and welded joints of situations.

Course Contents:-

1 Meaning of design with special reference to machine design, definition and understanding of various types of design, design process, design and creativity, general design considerations, concept of tearing, bearing, shearing, crushing, bending and fracture.

2. Designation of materials according to Indian standards code, basic criteria of selection of material, mechanical properties of materials.

3. Concept of concurrent engineering in design, introduction to 'Design for X' manufacturing considerations in machine design, stress concentration, factor of safety under different loading

conditions, design for static loading, design for variable loading for both limited and unlimited life, concept of fatigue and endurance strength.

4. **Design of fasteners**: Design of rivets for boiler joints, lozenge joints, eccentrically loaded joints. Design of spigot and socket cotter joint, gib and cotter joint and knuckle joint. Design of welded joints for various loading conditions in torsion, shear or direct loads, eccentrically loaded joints

5. **Design of shaft and axles**: Design of solid and hollow shafts for transmission of torque, bending moments and axial forces, Design of shaft for rigidity, Design of axle.

6. **Design of keys and couplings**: Design of keys, design of splines, design of sleeve and solid muff coupling, clamp or compression coupling, rigid and flexible flange coupling, design of universal joint.

7. **Design of levers and links**: Design of levers(foot lever, hand lever, cranked lever, bell crank lever, safety valve lever and shoe brake lever), design of link.

8. **Design of pipe joints**: Stresses in pipe joints, design of pipe joints with oval flange, square flange, design of seals and gaskets.

Books

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

2. Robert C. Juvinall Fundamentals of machine component design, Wiley

3. V.K Jadon, Analysis and design of machine elements, I.K. International

4. V.B Bhandari, Design of Machine elements, Tata Mc. Hill

5. S.S Jolly, Design of machine elements-I, Dhanpat Rai and Co.

COURSE	CAD/CAM
COURSE CODE	BTME- 502
SEMESTER	5th

COURSE Objectives:

1. Understand the applications and benefits of CAD and understand the various computer hardware devices.
2. Understand geometric transformation.
3. Understand various representations of curves and surfaces.
4. Understand the various concepts and characteristics in geometric modeling.
5. Apply CAD techniques to finite element mesh generation.
6. Understand the basic concepts of CAM
7. Understand the fundamentals and advantages of group technology.
8. Classify various CAPP systems.
9. Understand FMS and CIMS with reference to components, advantages and applications.

Course Outcome/s:

After completion of this course, the Students should be able to:

1. To describe the fundamental theory and concepts of the CAD/CAM.
2. Develop the concepts and underlying theory of modeling and the usage of models in different engineering applications.
3. Compare the different types of modeling techniques and explain the central role solid models play in the successful completion of CAD/CAM-based product development.
4. Develop transformations for 2D geometric modeling.
5. Distinguish the different CAD/CAM neutral files. Understand the import and export procedure of CAD/CAM electronic neutral files (IGES, STEP).
6. Apply both practices (manually and CAM) to develop the G-code program.
7. Develop part families.
8. Analysis the various process planning for manufacturing jobs.
9. To develop FMS and CIMS programming.

Detailed Contents

1. Fundamentals of CAD;

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

2. Geometric Transformations:

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

3. Geometric Modeling:

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

4. Representation of curves and surfaces:

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

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

6. NC/CNC Machine Tools;

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

7. Group Technology (GT):

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

8. Computer Aided Process Planning:

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

9. Computer Integrated Manufacturing Systems:

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

TEXT/ REFERENCE BOOKS:

T/R	**BOOK TITLE/ AUTHORS/ PUBLICATION**
T1	Mikell P. Groover, Emory W. Zimmers, CAD/CAM, PHI
T2	Zeid Ibraham, CAD/CAM - theory and Practice, Tata McGraw Hill
T3	P. N Rao, CAD/CAM, Tata McGraw Hill

Beyond the curriculum topics:

1. Detailed description of curves and surfaces.
2. NC/CNC programming for different profiles.

COURSE	Industrial Automation & Robotics
COURSE CODE	BTME- 504
SEMESTER	5th

Course Objectives:

1. Main objective of the Industrial automation and robotics is to familiarize the students with different types of automation in industry.
2. Introduce different components of automation to the students.
3. Make students able to design pneumatic and hydraulic automation circuits.
4. Illustrate them the role of fluidics in automation.
5. Introduce them electrical components like PLC which are used as part of automation, different types of feeding devices.
6. Last but not least giving the students a brief introduction about the mega field of robotics.

Course Outcomes

After studying this course, students shall be able to:

1. Understand the concept, need and application of hard automation, soft automation and their advantages.
2. Describe the constructional features, working and use of valves and their application in automation.
3. Conceptualize and design the pneumatic and hydraulic circuits for industrial automation applications.
4. Describe the working of fluidic sensors for their industrial applications.
5. Illustrate the role of PLC in automation and working of PLC.
6. Describe the constructional details and working of various transfer devices and feeders in manufacturing industry.
7. Illustrate the different aspects of field of robotics.

Detailed Contents

1.

Introduction:

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

2.

Fluid Power:

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

3. **Basic hydraulic and pneumatic circuits:**

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

Basics of Control Chain Circuit Layouts Designation of specific Elements in a Circuit

4. **Fluidics:** Boolean algebra, Truth Tables, Logic Gates, Coanda effect.
5. **Electrical and Electronic Controls :**Basics of Programmable logic controllers (PLC) Architecture & Components of PLC , Ladder Logic Diagrams
6. **Transfer Devices and feeders:** Classification, Constructional details and Applications of Transfer devices Vibratory bowl feeders Reciprocating tube Centrifugal hopper feeders

7. **Robotics** Introduction, Classification based on geometry, control and path movement, Robot Specifications, Robot Performance Parameters Robot Programming

Machine Vision, Teach pendants Industrial Applications of Robots

TEXT/ REFERENCE BOOKS:

T/R	BOOK TITLE/ AUTHORS/ PUBLICATION
R1	S.R. Majumdar, Pneumatic control, Mc graw hill
R2	J. Graig, Introduction to robotics Robotics, Pearson

Beyond the curriculum topics:

1. Pneumatic and hydraulic circuit design for customized problems.
2. Sensors/ Transducers
3. Introduction to robotic kinematic inversions.

6TH SEMESTER

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

BTME 602 HEAT TRANSFER

Course Objectives

The aims of this course are:

1. To make the students understand the fundamentals of heat transfer mechanisms in fluids and solids.
2. To enhance the student's ability in analyzing, calculating and designing the equipments for measurements of temperature/ heat flow etc.
3. To enhance the student's ability in solving problems arising in the field of heat engineering.

Course Outcomes

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

CO1- Understand the basic laws of heat transfer.

CO2- Analyze and develop solutions for problems involving steady / transient state heat conduction in simple geometries.

CO3- Understand the fundamentals of convective heat transfer process and evaluate heat transfer coefficients for natural, forced convection.

CO4- Analyze heat exchanger performance by using log mean temperature difference and heat exchanger effectiveness.

CO5- Calculate radiation heat transfer between black body, gray body surfaces.

Course Contents

1. Introduction

Concept of heat transfer, Difference between the subject of "Heat Transfer" and its parent subject "Thermodynamics". Different modes of heat transfer - conditions, convection, radiation.

2. Conduction

Fouier's law of heat conduction, coefficient of thermal conductivity, effect of temperature and pressure on thermal conductivity of solids, liquids and gases and its measurement. Three-dimensional general conduction equation in rectangular, cylindrical and spherical coordinates involving internal heat generation and unsteady state conditions. Derivation of equations for simple one dimensional steady state heat conduction from three dimensional equations for heat conduction though walls, cylinders and spherical shells (simple and composite), electrical analogy of the heat transfer phenomenon in the cases

discussed above. Equivalent areas, shape factor, conduction through edges and corners of walls and critical thickness of insulation layers on electric wires and pipes carrying hot fluids. Internal generation cases along with some practical cases of heat conduction like heat transfer through underground electrical cables, simple model of heat conduction through piston crown and case of nuclear fuel rod with cladding. Influence of variable thermal conductivity on conduction through simple cases of walls / cylinders and spheres. Introduction to unsteady heat transfer, Newtonian heating and cooling of solids; definition and explanation of the term thermal diffusivity.

3. Theory of Fins

Straight rod type of fins of uniform cross-section; e.g. of circular, rectangular or any other cross-section). Straight fins with varying cross-sectional area and having triangular or trapezoidal profile area, circumferential find of rectangular cross-section provided on the circumference of a cylinder. Optimum design of straight find of rectangular and triangular profile cross-sections; fin effectiveness and fin efficiency for straight rod fins of rectangular and circular cross-section. Application of fins in temperature measurement of flow through pipes and determination of error in its measurement.

4. Heat Exchangers

Newton's law of cooling. Overall coefficient of heat transfer. Different design criterion for heat exchangers. Log mean temperature difference for evaporator and condenser tubes, and parallel and counter flow heat exchangers. Calculation of number and length of tubes in a heat exchanger.

5. Convection

Free and forced convection, derivation of three-dimensional mass, momentum and energy conservation equations (with introduction to Tensor notations). Boundary layer formation, laminar and turbulent boundary layers (simple explanation only and no derivation). Theory of dimensional analysis as applied to free and forced convective heat transfer. Analytical formula for heat transfer in laminar and turbulent flow, flow over vertical and horizontal tubes and plates.

6. Convection with Phase Change (Boiling and Condensation)

Pool boiling, forced convection boiling, heat transfer during pool boiling of a liquid. Nucleation and different theories of nucleation, different theories accounting for the increased values of h.t.c. during nucleate phase of boiling of liquids; different phases of flow boiling (theory only)

7. Radiation

Process of heat flow, definition of emissivity, absorptivity, reflectivity and transmissivity. concept of black and grey bodies, Plank's law of nonchromatic radiation. Kirchoff's law and Stefan Boltzman's law. Interchange factor. Lambert's Cosine law and the geometric factor. Intensity of Radiation (Definition only), radiation density, irradiation, radiosity and radiation shields. Derivation formula for radiation exchange between two bodies using the definition of radiosity and irradiation and its application to cases of radiation exchange between three or four bodies (e.g. boiler or other furnaces), simplification of the formula for its application to simple bodies like two parallel surfaces, concentric cylinders and a body enveloped by another body etc. Error in Temperature measurement by a thermocouple probe due to radiation losses.

TEXT/ REFERENCE BOOKS:

1. R K Rajput, “Heat Transfer”, Sixth edition, S K Kataria & Sons, 2007
2. D.S. Kumar, Fundamentals of Heat and Mass Transfer, SK Kataria & Sons (6th/7th Edition)
3. A Course in Heat and Mass Transfer by S Domkundwar; Dhanpat Rai and Sons, Delhi
4. Heat Transfer by AJ Chapman; Macmillan Publishing Company, New York
5. Heat transfer by JP York Holmans, McGraw London

WEB SOURCE REFERENCES:

http://nptel.ac.in/courses/112108149/

http://nptel.ac.in/courses/103103032/

DOM-II (BTME-601)

Course Objectives: After completion of this course the students will be able to…

1	Reinforce the philosophy that real engineering design problems are open-ended.
2	Give practice in longer open-ended problems using design methodology.
3	Enable students to apply engineering tools/techniques to component design.
4	Broaden skills in team work, critical thinking, communication, planning and scheduling throughdesign problems.
5	Enable students to consider safety, ethical, legal, and other societal constraints in execution of theirdesign projects.
6	Enable students to attain the basic knowledge required to understand, analyze, design and selectmachine elements.

Course Outcomes

CO1	Ability to design and analyze Mechanical transmission systems.
CO2	Ability to design and select different types of bearings from manufacturer's catalogue.
CO3	Ability to design and select different types of flywheel.
CO4	Ability to design and select different types of springs.
CO5	Ability to design and select different types of clutches and brakes.

COURSE CONTENT

1. Transmission Drives

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

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

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

2. Bearings Slider: Principle of hydrodynamic lubrication, modes of lubrication, Reynolds equation, bearing performance parameters, slider bearing design Roller: Types, selection guidelines, static and dynamic load carrying capacity, Stribeck's equation, equivalent bearing load, load life relationship, selection of bearing, comparison of Roller and slider bearing
3. Design of Flywheel Introduction, Energy stored in a flywheel, stresses in a rim, design considerations
4. Springs Types; end styles of helical compression spring; stress and deflection equation; surge in spring; nipping of leaf spring; Design of close-coil helical spring and multi leaf spring.
5. Clutches Design of contact clutches i.e. plate, multi-disc, cone and centrifugal clutches
6. Brakes Design of band, disc, block with shoe and internal expanding brakes.

TEXT/ REFERENCE BOOKS:

T/R	BOOK TITLE/ AUTHORS/ PUBLICATION
T1	MachineDesignbySharma,Aggarwal,Kat ariaPublishers.
T2	MachineDesignbyR.S.Khurmi,S.ChandPublishers.
R1	Joseph E. Shigley, Charles Russell Mischke, Richard Gordon Budynas, Mechanical Engineering Design, McGraw-Hill
R2	V.K Jadon, Analysis and design of machine elements, I.K. International

WEB SOURCE REFERENCES:

1	machinedesign.com
2	https://www.machinedesignonline.com
3	nptel.ac.in/courses/112105124/

4	nptel.ac.in/courses/112106137/
5	http://www.indiabix.com/mechanical-engineering/machine-design/

DE/ME-3.8 MECHATRONICS

Course Objectives:

Have a strong foundation in science and focus in mechanical, electronics, control, software, and computer engineering, and a solid command of the newest technologies.

Be able to design, analyze, and test "intelligent" products and processes that incorporate appropriate computing tools, sensors, and actuators.

Be able to work efficiently in multidisciplinary teams.

Course Outcomes

After the completion of the course the student will be able to:

CO1. To define the engineering problem related to mechatronics.

CO2. Design mechatronics components, system or process to meet desired needs employing the knowledge of mathematics, science, and engineering.

CO3. Use the techniques, skills, and mechatronics engineering necessary for engineering practice.

CO4. Function effectively as members of multidisciplinary teams.

Syllabus

DE/ME-3.8 MECHATRONICS

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

1. Introduction to Mechatronics:

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

2. Sensors and Transducers:Performance Terminology, Displacement, velocity, Position, Proximity, force, fluid pressure, liquid level, temperature, light sensors, procedure for selection.

3. Signal Conditioning:

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

4. Pneumatic and Hydraulic Systems:

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

5. Electrical Actuation System:

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

6. Microprocessor and Its Application:

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

7. Microprocessor Based Project:

Assemble a suitable system using microprocessor kit for its control.

TEXT/ REFERENCE BOOKS:

T/R	BOOK TITLE/ AUTHORS/ PUBLICATION
T1	W. Bolton, Mechatronics, Pearson Education.
T1	D. Alciatore, Mechatronics, McGrawHill Education
R1	Rafiquzzaman, Microprocessors
R2	S. Boennett, Real time computer controls, Prentice Hall.
R3	Benjamin C. Kuo, Automatic Control Systems, Prentice Hall.

List of Videos and internet material referred

1. http://www.iitk.ac.in/robotics/
2. https://www.vidyarthiplus.com/vp/attachment.php?aid=41801
3. https://www.youtube.com/watch?v=Ro_tFv1iH6g
4. https://www.youtube.com/watch?v=_f9gU7iR1c8&spfreload=5
5. https://www.youtube.com/watch?v=1toabvjI0PM

Expert lectures

S.No	Date of Expert talk	Name of the resource person	Designation and affiliation	Topic of presentation
1.	**March 02-03, 2017**	**Wingfotech Pvt. Ltd.**	**In collaboration with IIT, Delhi**	**Workshop on Quad-Copter**

GAPS IN SYLLABUS

THE SYLLABUS – TO MEET INDUSTRY/ PROFESSION REQUIREMENTS:

S. NO	DESCRIPTION	PROPOSED ACTIONS	PO Mapping
1.	Microcontroller Theory	To be discussed in brief with students	PO 5

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/ DESIGN:

S.No.	Description	PO Mapping
1	Microcontroller Theory	PO 5

Tool Design

Course Objectives

1. Understand basic motions nvolved in a machine tool.
2. Design machine tool structures.
3. Design and analyze systems for specified speeds and feeds.

Course Outcomes

CO-1 Students will able to Select subsystems for achieving high accuracy in machining.

CO-2 Understand control strategies for machine tool operations.

CO-3 Apply appropriate quality tests for quality assurance.

1. Process Planning:
Product Engineering, Process Engineering, Definition of Process Planning, Contents of Process Plan, Process Operations, Steps of Process Planning, Process Planning Sheet, Planning and Tooling for Low Cost Planning.
2. Jigs and Fixture:
Principles of jig and fixture design, Principle of degrees of freedoms, methods of locations and clamping, Various devices for location and clamping, indexing devices, Hydraulic and pneumatic actuation of clamping devices, jig bushes, use of standard parts of jig design, type of drilling jigs, milling fixtures, lathe fixture, grinding fixtures and their classification.

3. Die Design:
Components of die design, design of die blocks, punches and strippers, methods of holding punches, sketches of stock stops, Design procedure for progressive dies, compound dies and combination dies for press tool operation forging die design for drop and machine forging parts.
4. Tool Layout for Turrets:
Characteristics of Turret lathes, Differences between capstan and turret lathes, methods of holding jobs on the Turret lathe, Universal chucking equipment, universal bar equipment, operation sheet and tool layout.
5. Tool Layout for Automatics:
Classification of Automatics, Turret type automatic, tool layout procedure, time required for each operation, operation sheet, tool layout, cam layout.
6. Tooling Costs:
Estimating cost of a product, estimating costs of tools, Economics of tooling, Break even point

analysis, minimum cost analysis.

7. Gauges:

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

8. Surface Finish:

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

Books

Tool Design by donaldson

FLUID MACHINERY

BTME-603

Course Objectives

The aims of this course are:

1. To make the students understand the principles and mechanisms of conversion of hydraulic energy into mechanical energy/work.
2. To introduce a variety of techniques of analyzing and utilizing the energy/power contained in a flowing medium.
3. To develop the student's familiarity & competence in analyzing, calculating and designing the equipments for hydraulic energy utilization employing both analytical and numerical techniques.
4. To enhance the student's ability to apply system analysis and problem solving skills in various situations that may arise in the field of hydraulics.

Course Outcomes

After successful completion of this course the student must be able to:

8. Derive the relationships for various situations and varying parameters in the hydraulic circuits.
9. Sketch and explain the constructional features and their importance/function of the parts that constitute a hydraulic machine/component.
10. Calculate the resulting effect on the input by varying the parameters at the input of a hydraulic machine/component.
11. Analyze and solve the problems like unintentional variation in output/Noise/Vibrations etc.
12. Evaluate the results of varying input parameters and analyze the pros and cons of each variation.
13. Predict the effect of each change in input parameter and thereby suggest an optimum solution to the problem.

14. Design the hydraulic component/machine/circuit according to the requirements of the situation.
15. Design prototypes according to the principles of unit and specific quantities.

Course Contents

1. General Concepts:

Impulse momentum principle; jet impingement on stationary and moving flat plates, and on stationary or moving vanes with jet striking at the centre and tangentially at one end of the vane; calculations for force exerted, work done and efficiency of jet. Basic components of a turbo machine and its classification on the basis of purpose, fluid dynamic action, operating principle, geometrical features, path followed by the fluid and the type of fluid etc. Euler's equation for energy transfer in a turbo machine and specifying the energy transfer in terms of fluid and rotor kinetic energy changes.

2. Pelton Turbine:

Component parts and operation; velocity triangles for different runners, work output; Effective head, available power and efficiency; design aspects such as mean diameter of wheel, jet ratio, number of jets, number of buckets with working proportions

3. Francis and Kaplan Turbines:

Component parts and operation velocity triangles and work output; working proportions and design parameters for the runner; Degree of reaction; Draft tubes - its function and types. Function and brief description of commonly used surge tanks, Electro- Mechanical governing of turbines

4. Centrifugal Pumps:

Layout and installation; Main elements and their functions; Various types and classification; Pressure changes in a pump - suction, delivery and manometric heads;

vane shape and its effect on head-capacity relationships; Departure from Euler's theory and losses; pump output and efficiency; Minimum starting speed and impeller diameters at the inner and outer periphery; Priming and priming devices, Multistage pumps - series and parallel arrangement; submersible pumps. Construction and operation; Axial and mixed flow pumps; Trouble shooting - field problems, causes and remedies.

5. Similarity Relations and Performance Characteristics:

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

6. Reciprocating Pumps:

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

7. Hydraulic Devices and Systems:

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

Books Consulted/Prescribed/Recommended

Prescribed Text Books

1. Fluid Mechanics and Hydraulic Machines by R K Bansal (Luxmi Publications)
2. Fluid Mechanics and Fluid Power Engineering by D S Kumar (S. K Kataria & Sons)

Reference Books

1. Fluid Mechanics and Machinery
   by R. Chanamala & A. V. Kothapalli (I K International Publishing House Pvt. Ltd)

2. Fluid Machinery: Application, Selection and Design
   by Terry Wright & Philip Gerhart (CRC Press)
3. Fluid Mechanics and Machinery
   by C.S.P. Ojha, R. Berndtsson & P. Chandramouli (Oxford University Press)

Reference Books for Objective type competitions

1. ESE 2017 Stage 1 (Prelims) Mechanical Engineering Objective Volume 1, Previous Objective Questions with Solutions by ACE Engineering Publications

Topics Beyond Curriculum

The syllabus designed and circulated by the affiliating university is comprehensive yet traditional. The syllabus related to hydroelectric power plants is more of theoretical nature with entire concentration of ideal circumstances. It does not cover the real life circumstances/problems and the solutions which the budding engineers will be asked to handle. Especially with the risks associated with global warming, natural disasters/occurrences have gained on the frequency and magnitude posing a threat to natural resources by the Mother Nature itself. As far as the Hydro electric power plants are concerned, there are two major topics that the students shall be well versed with:

1. **Turbine blades wear due to abrasion by silt particles in water.**
2. **Depletion of water quantity in the reservoir due to excessive sedimentation.**

It is required that the students be aware of the underlying reasons of these threats to the longevity of a power plant and the possible solution that have been used in the past and/or new technologies/researches catering to the need in the present scenario.

Secondly the curriculum is well designed to give an insight into hydraulic devices and how hydraulics is involved in our lives through various equipments. However, the entire range of our devices work on the basis of valves/actuator and fittings which are very important to study failing which the knowledge of hydraulics is incomplete. Accordingly, the following topics are introduced to the students:

1. **Hydraulic actuators**
2. **Hydraulic valves**
3. **Other circuits and components**

List of Web Resources and Address

http://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/machine/ui/Course_home-1.htm

http://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/machine/ui/Course_home-2.htm

http://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/machine/ui/Course_home-3.htm

http://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/machine/ui/Course_home-4.htm

http://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/machine/ui/Course_home-5.htm

http://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/machine/ui/Course_home-6.htm

http://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/machine/ui/Course_home-7.htm

http://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/machine/ui/Course_home-8.htm

http://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/machine/ui/Course_home-9.htm

http://nptel.ac.in/courses/105107059/module6/lecture4/lecture4.pdf

https://inspectapedia.com/water/Water_Pump_Repair_Guide.php

https://inspectapedia.com/water/Well_Pump_Priming_FAQs.php

https://inspectapedia.com/water/Well_Pump_FAQs.php

https://inspectapedia.com/water/Poor_Water_Pressure_Diagnosis.php

7TH SEMESTER

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

7th /8th Semester B.Tech (Mechanical)								
Code	**Title of the course**	**L**	**T**	**P**	**Maximum Marks**		**Total Marks**	**Credits**
					Internal	**External**		
BTME-801	Industrial Engineering and Management	4	-	-	40	60	**100**	4
BTME-802	Refrigeration & Air Conditioning	4	1	-	40	60	**100**	5
BTME-803	Mechanical Vibrations	4	1		40	60	**100**	5
BTME-DE/	Department Elective-II	4	-	-	40	60	**100**	4
	Open Elective	4			40	60	**100**	4
BTME-804	Refrigeration & Air Conditioning Lab	-	-	2	30	20	**50**	1
BTME-805	Mechanical Vibration lab	-	-	2	30	20	**50**	1
BTME-806	Major Project*	-	-	6	100	50	**150**	3
	Advisory meeting	-	-	1	-	-	-	-
GF 800	General Fitness	-	-	-	100	-	**100**	-
	Total	**20**	**2**	**11**	**460**	**390**	**850**	27
Total Contact Hours = 33								

Industrial Engg. & Management (BTME-801)

Course Objectives

The aims of this course are:

5. To make the students understand the industry concepts, industry management systems.
6. To understand the overview of the industry and management concepts this deals systems or organizations and its structure.
7. To understand various techniques of work & method study and how to implement the various analysis techniques in the environment of industry to improve the productivity of an organization.
8. To understand various Industrial techniques to find out the reason of low productivity.

Course Outcomes:

After completion of the course students will be able to :

CO1- Understand the overview of the industry and management concepts which deals with the optimization of complex processes, systems or organizations.

CO2- Learn scope of industrial engineering, concept of production and productivity.

CO3- Learn about the functions of industrial engineering, principles of management and organizational structures.

CO4- Understand the industrial engineers work to eliminate waste of time, money, materials, man-hours, machine time, energy and other resources.

CO5: Understand how to implement the various techniques of work & method study and how to implement the various analysis techniques in the environment of industry to improve the productivity of an organization.

Course Contents:

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.

REFRIGERATION AND AIR-CONDITIONING (BTME-802)

COURSE OBJECTIVES:

1	Learning the fundamental principles and different methods of refrigeration and air conditioning.
2	Study of gas and vapour refrigeration cycles and evaluate performance using refrigerant property tables/gas laws.
3	Comparative study of different refrigerants with respect to properties, applications and environmental issues.
4	Study of non-conventional and low temperature refrigeration systems with a focus on understanding the underlying principles and applications.
5	To familiarize with properties of moist air and psychrometric chart
6	To understand various airconditioning processes and calculate cooling load for its applications in comfort and industrial air conditioning.
7	To familiarize with various components of refrigeration and airconditioning systems.

COURSE OUTCOMES:

After the completion of the course, students will be:

Sr. No.	Description
CO-1	Able to illustrate the underlying principles, types and applications of refrigeration and air conditioning systems and the equipment involved.
CO-2	Able to calculate the performance and cooling capacity of vapour compression and gas cycle based refrigeration systems.
CO-3	Familiar with the different refrigerants, their physical and thermodynamic properties and relative applications and will be able to make a selection of a refrigerant for a given application and refrigeration system.
CO-4	Equipped with understanding of the applications of cryogenics and processes used to attain ultra low temperatures for liquefaction of gases.
CO-5	Able to determine the properties of moist air and demonstrate the various airconditioning processes and plot the same on psychrometric charts.
CO-6	Able to calculate the cooling load of a space to be air-conditioned and design a cooling systems for the same.

Syllabus

1. **Basic Concepts:** Definition of Refrigeration and Air conditioning; Difference between Refrigeration and cooling; Difference between Refrigeration and Air conditioning; Brief history of Refrigeration and Air conditioning; Natural and Mechanical Refrigeration; Applications of Refrigeration and Air conditioning; Definitions of refrigerant, cooling/ Refrigeration effect, cooling capacity, heating effect, heating capacity; Units of refrigeration; Coefficient of performance and Energy Efficient Ratio; COP of a refrigerator; and COP/EPR of a heat pump; Single Phase Reversed Carnot cycle and its limitations; Two Phase Reversed Carnot cycle and its limitations; Methods of Refrigeration; Numerical.

2. **Gas Cycle Refrigeration and Aircraft Refrigeration & Air conditioning**: Bell Coleman/Reversed Brayton/ Reversed Joule Cycle and its analysis; Numerical; optimum COP and pressure ratio (No mathematical Analysis); Applications of Gas Cycle Refrigeration; Necessity of aircraft refrigeration and air conditioning; Classification of aircraft refrigeration and air conditioning systems; Simple/basic aircraft refrigeration and air conditioning system (with and without evaporative cooler); Need of evaporator cooler; Boot Strap aircraft refrigeration and air conditioning system (with and without evaporative cooler); Regenerative aircraft refrigeration and air conditioning system; Reduced Ambient aircraft refrigeration and air conditioning system; Dry Air Rated Temperature (DART); Comparison of different aircraft refrigeration and air conditioning systems; Numerical.

3. **Vapour Compression Refrigeration Cycle**: Vapour compression refrigeration system and its basic components; Representation of Simple/ TheoreticaL vapour compression refrigeration cycle on P-v, T-s and P-h diagrams; Dry versus wet compression; expansion versus throttling of liquid refrigerant; Analysis of Simple/Theoretical vapour compression refrigeration cycle; Introduction of P-h diagram/chart and Refrigeration Tables; Determination of properties of sub cooled, saturated and superheated refrigerant by using saturated properties & specific heat tables/saturated & superheated properties tables and P-h diagram; Compressor work and volumetric efficiency; Effect on performance and cooling capacity due to change in evaporator pressure, condenser pressure, sub cooling of liquid refrigerant, super heating of suction vapours, use of liquid - vapour regenerative heat exchanger; Effect on performance and cooling capacity due to heat exchange of vapours with compressor cylinder walls, pressure drop in suction (wire drawing) and discharge valves, pressure drop in evaporator and condenser; Actual vapour compression refrigeration cycle on T-s and P-h diagrams (No mathematical analysis); Numericals. Flash gas, its advantages and disadvantages, and its removal: flash chamber, liquid sub-cooler; Brief introduction (no mathematical analysis) to compound (multistage) compression, its advantages, schematic representation of these systems with use of flash chamber, water intercooler, flash intercooler, liquid sub-cooler (independent and combination of these); Brief introduction (no mathematical analysis) to multiple evaporator systems, schematic representation of these systems with use of individual and multiple expansion valves arrangements, with single and multiple (individual and compound) compressor.

4. **Vapour Absorption Refrigeration Cycle (No Mathematical Analysis):** Principle of vapour absorption refrigeration; basic components of the vapour absorption refrigeration system; Desirable properties of absorption system refrigerant and absorbent; Aqua - ammonia vapour absorption refrigeration system; Lithium Bromide - water absorption system (Single and double effect);Electrolux refrigeration system; comparison between vapour absorption and compression systems.

5. **Refrigerants:** Classification and nomenclature of refrigerants; Desirable thermodynamic, chemical and physical properties of refrigerants; comparative study of commonly used refrigerants and their fields of application; Azeotropes; Zeotropes; Effect of moisture and oil miscibility; Refrigerants dying agents and antifreeze solution; leak detection and charging of refrigerants; environmental aspects of conventional refrigerants; Ecofriendly refrigerants and action plan to reduce ecological hazards.

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

7. **Air Conditioning Concepts and Applications:** Psychrometry; Dry Air; Moist Air; Basic laws obeyed by Dry Air and Moist Air; Psychrometric properties of air: Dry bulb, wet bulb and dew point temperatures, Relative and specific humidity, degree of saturation adiabatic saturation temperature, enthalpy of air and water vapours; Psychrometric chart and its use; Adiabatic mixing of moist air streams without condensation and with condensation; Numerical. Human requirement of comforts; effective temperature and comfort charts; Industrial and comfort air conditioning.

8. **Psychometric Processes:** Basic psychrometric processes; Sensible heat process; Latent heat process;Total heat process; Sensible heat factor; Evaporative cooling; cooling with dehumidification; Heating with dehumidification; chemical dehumidification; By-pass factor; Contact factor; Psychrometric processes in air conditioning equipment: Cooling coils, Heating coils, cooling and dehumidification coils, Evaporative coolers, Adiabatic dehumidifiers, Steam injection, Air washer; Numerical.

9. **Calculations for Air conditioning Load and for Rate and state of Supply Air:** Sources of heat load; sensible and latent heat load; Cooling and heating load estimation; Apparatus dew point temperature; Rate and state of supply air for air conditioning of different types of premises; Numerical

10. **Refrigeration and Air Conditioning Equipment:** Brief description of compressors, condensers, evaporators and expansion devices; Cooling towers; Ducts; dampers; grills; air filters; fans; room air conditioners; split units; Package and central air conditioning plants.

Text books:

Book Title	Author	Publisher
A course in refrigeration and airconditioning	Domkundwar, Arora and Domkundwar	Dhanpat Rai and Sons
Refrigeration and Air-conditioning	C P Arora	McGraw Hill Education Pvt. Ltd.
A course in refrigeration and air-conditioning	R. S. Khurmi	S Chand Publishers

Reference Books

Book Title	Author	Publisher
Refrigeration and Air-conditioning	R C Arora	PHI Learning
ASHRAE Handbook (Fundamentals)		ASHRAE
ASHRAE Handbook (Refrigeration)		ASHRAE
Principles of Refrigeration	Roy Dossat	Pearson Education India
Refrigeration and Conditioning	Manohar Prasad	Wiley Eastern Limited
Air-conditioning Principles and Systems	Edward G. Pita	PHI Learning Pvt. Ltd.

Recommended MOOCs

Course Title	Link	Course coordinated by
Refrigeration and Air-conditioning	http://nptel.ac.in/courses/112105128/	IIT Kharagpur

BTME-803 MECHANICAL VIBRATIONS

Course Objectives

An introductory course in linear mechanical vibrations where students acquire the ability to

a. Formulate mathematical models of problems in vibrations using Newton's second law or energy principles,
b. Determine a complete solution to mechanical vibration problems using mathematical or numerical techniques, and
c. Determine physical and design interpretations from the results.
d. Correlate results from the mathematical model to physical characteristics of the actual system.
e. Design of a mechanical system using fundamental principles developed in the class.
f. Develop an ability to analyze continuous systems.

Course Outcomes

1. Students will be able to construct the equations of motion for free-body diagrams.
2. Students will be able to solve for the motion and the natural frequency of (i) a freely vibrating single degree of freedom undamped motion and (ii) a freely vibrating single degree of freedom damped motion.
3. Students will be able to construct the governing differential equation and its solution for a vibrating mass subjected to an arbitrary force.
4. Students will be able to solve for the motion and the natural frequency for forced vibration of a single degree of freedom damped or undamped system.
5. Students will have an ability to obtain the complete solution for the motion of a single degree of freedom vibratory system (damped or undamped) that is subjected to non-periodic forcing functions.
6. Students will be able to solve vibration problems that contain two degrees of freedom.
7. Students will be able to solve vibration problems that contain multiple degrees of freedom.
8. Students will be able to obtain numerical solutions to vibration problems by simple algorithms, and display the findings in graphical form.
9. Students will be able to obtain design parameters and indicate methods of solution for a complicated vibratory problem.

Syllabus

BTME-803 Mechanical Vibrations

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

1. **Introduction**:

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

2. **Vibration of Single Degree of Freedom System**:

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

3. **Two degrees of Freedom systems**:

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

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

4 **Multi-degree of freedom systems**:

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

5. **Continuous systems**:

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

TEXT/ REFERENCE BOOKS:

T/R	BOOK TITLE/ AUTHORS/ PUBLICATION
T1	V.P Singh, Mechanical Vibrations
T2	S.S Rao , Mechanical Vibration
R1	D.M Grover, Mechanical Vibration
R2	C.Sujatha, Vibration and Acoustics

List of Videos and Internet Materials Referred

WEB SOURCE REFERENCES:

1	http://freevideolectures.com/Course/2684/Mechanical-Vibrations
2	https://www.youtube.com/watch?v=9_d8CQrCYUw
3	http://nptel.ac.in/courses/112103111/
4	http://web.itu.edu.tr/~gundes/sdof.pdf

COURSE	Industrial Tribology
COURSE CODE	DE/ME-3.6

COURSE Objectives:

The primary objectives of the course are to understand:

1. Different types of surfaces and their properties.
2. The role played by friction in different type of surface contacts.
3. Theories behind friction.
4. The phenomenon of wear and its measurement.
5. The role of lubrication and different types of lubricants.
6. Different tribological considerations in bearing design.

Course Outcome/s:

After completion of this course, the Students should be able to:

1. Elaborate laws of sliding friction and measurement of friction.
2. Illustrate mechanism of wear & measurement of wear in various environmental conditions.
3. Suggest ways and means for prevention and control of wear and friction in machines.
4. Describe different methods of lubrication and different types of lubricants.
5. Illustrate the design of bearings, with tribological considerations.

Detailed Contents:

1. Introduction:

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

2. Friction and Wear:

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

3. Lubrication and Lubricants:

Introduction, dry friction, Boundary lubrication, classic hydrodynamics, hydrostatic and elasto hydrodynamic lubrication, Functions of lubricants, Types of lubricants and their industrial uses, properties of liquid and grease lubricants; lubricant additives , general properties and selection.

4. Special Topics:

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

TEXT/ REFERENCE BOOKS:

T/R	BOOK TITLE/ AUTHORS/ PUBLICATION
R1	o' conner and royale, a handbook on lubrication, tata mc graw hill
T1	J. Halling, Introduction to tribology, Wylkhem publications

Beyond the curriculum topics:

1. Case studies on lubrication, friction.
2. Design of bearings with lubrication considerations.

Recommended MOOC's :

http://nptel.ac.in/courses/112102014/

Recommended Videos:

https://www.youtube.com/watch?v=45CcdjPrxoM

https://www.youtube.com/watch?v=RZXxlZ5SWpQ