1.1.3

Supporting Documents-

Department of Mechanical Engineering

Syllabus of Courses Highlighting the Focus on Employability/Entrepreneurship/Skill Development

1.1.3 & 1.2.1

Supporting Documents- Mechanical Engineering

Syllabus of courses highlighting the focus on employability / entrepreneurship/skill development

Semester IV (Second year]

Course Type	Course Code	Course Title	Load Allocations			Marks Distribution		Total Marks	Credits
			L	T	P	Internal	External		
Professional Core courses	BTME401-18	Applied Thermodynamics	3	1	0	40	60	100	4
Professional Core courses	BTME402-18	Fluid Machines	3	1	0	40	60	100	4
Professional Core courses	BTME403-18	Strength of Materials-II	3	1	0	40	60	100	4
Engineering Science courses	BTME404-18	Materials Engineering	3	0	0	40	60	100	3
Professional Core courses	BTME405-18	Theory of Machines-II	3	1	0	40	60	100	4
Mandatory courses	EVS101-18	Environmental Science	3	-	-	100	0	100	0
Professional Core courses	BTME406-18	Applied Thermodynamics (Lab)	0	0	2	30	20	50	1
Professional Core courses	BTME407-18	Fluid Machines (Lab))	0	0	2	30	20	50	1
Professional Core courses	BTME408-18	Material Engineering (Lab)	0	0	2	30	20	50	1
Mandatory courses	BMPD401-18	Mentoring and Professional Development	0	0	2	Satisfactory / Un-Satisfactory			Non-Credit
Total			18	4	8	390	360	750	22

Semester V (Third year)

Course Type	Course Code	Course Title	Load Allocations			Marks Distribution		Total Marks	Credits
			L	T	P	Internal	External		
Professional Core courses	BTME501-18	Heat Transfer	4	1	0	40	60	100	5
Professional Core courses	BTME502-18	Design of Machine Elements	4	1	0	40	60	100	5
Professional Core courses	BTME503-18	Manufacturing Processes	4	0	0	40	60	100	4
Mandatory courses	BTME504-18	Management and Engineering Economics	3	0	0	40	60	100	3
Professional Core courses	BTME505-18	Heat Transfer (Lab)	0	0	2	30	20	50	1
Professional Core courses	BTME506-18	Manufacturing Processes (Lab)	0	0	2	30	20	50	1
Engineering Science courses	BTME507-18	Numerical Methods (Lab)	0	0	3	30	20	50	1.5
Mandatory courses	BTMC102-18	Essence of Indian knowledge Tradition	3	0	0	100	00	100	Non-Credit
	BTME409-18	4-weeks Industrial Training *	0	0	6	60	40	100	Non-credit
Total			18	2	13	410	340	750	20.5

* The grade of Satisfactory/ Un-satisfactory of Industrial/Institutional Training imparted at the end of 4th Semester will be included here.

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6th Semester Study Scheme

Course Type	Course Code	Course Title	Load Allocations			Marks Distribution		Total Marks	Credits
			L	T	P	Internal	External		
Professional Core courses	BTME601-18	Refrigeration and Air conditioning	3	1	0	40	60	100	4
Professional Core courses	BTME602-18	Mechanical Measurements & Metrology	4	0	0	40	60	100	4
Professional Core courses	BTME603-18	Automobile Engineering	3	0	0	40	60	100	3
Mandatory courses	BTME604-18	Introduction to Industrial management.	3	1	0	40	60	100	4
Professional Elective		Elective-I	3	0	0	40	60	100	3
Professional Core courses	BTME605-18	Refrigeration and Air conditioning (Lab)	0	0	2	30	20	50	1
Professional Core courses	BTME606-18	Mechanical Measurements & Metrology (Lab)	0	0	2	30	20	50	1
Professional Core courses	BTME607-18	Auto. Engg. (Lab)	0	0	2	30	20	50	1
Professional Core courses	BTME608-18	Minor Project	0	0	2	30	20	50	1
Total			16	2	08	290	380	700	22

The project work will be carried out in parts as minor project in 6th semester and major project in 7/8th semester. The literature survey, problem formulation, assessment for viability of the project, objectives and methodology for the project shall be decided in 6th semester. The same project problem is to be extended in the major project in semester. The minor project may be carried out by a group of students 2 to 4.

List of Elective I, II and III (For 6th, 7th and 8th semester)

Sr. No.	Name of Subject	Subject Code
1)	Internal Combustion Engines.	BTME609-18
2)	Mechatronics Systems.	BTME610-18
3)	Microprocessor in Automation	BTME611-18
4)	Composite Materials	BTME612-18
5)	Computer Aided Design.	BTME613-18
6)	Product Design and Development	BTME614-18
7)	Non-Conventional Energy Resources.	BTME615-18
8)	Operation Research	BTME616-18
9)	Maintenance and Reliability	BTME617-18

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Semester 7th / 8th

Course Type	Course Code	Course Title	Load Allocations			Marks Distribution		Total Marks	Credits
			L	T	P	Internal	External		
Professional Core courses	BTME701-18	Mechanical Vibrations	3	1	0	40	60	100	4
Professional Core courses	BTME702-18	Automation in Manufacturing	3	0	0	40	60	100	3
Professional Core courses	BTME703-18	Fundamentals of Management for Engineers	3	0	0	40	60	100	3
Professional Elective courses		Elective-II	3	0	0	40	60	100	3
Professional Elective courses		Elective-III	3	0	0	40	60	100	3
Choose from other department		Open Elective	3	0	0	40	60	100	3
	BTME704-18	Project-II	0	0	8	40	60	100	6
Total			18	1	8	280	420	700	25

Semester 7th / 8th

Course Code	Course Title	Evaluation Internal		External	Total Marks	Credits
		Institute	Industry			
BTME-801	Software Training	100	50	100	250	8
	Industrial Training	100	50	100	250	8
	Total	200	100	200	500	16

List of Open Elective Subject offered to other Departments :

Sr. No.	Name of Subject	Subject Code
1)	Internal Combustion Engines.	BTME609-18
2)	Mechatronics Systems.	BTME610-18
3)	Microprocessor in Automation	BTME611-18
4)	Composite Materials	BTME612-18
5)	Computer Aided Design.	BTME613-18
6)	Product Design and Development	BTME614-18
7)	Non-Conventional Energy Resources.	BTME615-18
8)	Operation Research	BTME616-18
9)	Maintenance and Reliability	BTME617-18

Subject offered for Minor Degree in B. Tech. Mechanical Engineering

Core Subjects

Sr. No.	Subject Code	Couse Title	Credits
1	BTME501-18	Manufacturing Processes	4

Elective Subject (Odd Semester)

Sr. No.	Subject Code	Couse Title	Credits
1	BTME301-18	Fluid Mechanics	4
2	BTME302-18	Theory of Machines-I	4
3	BTME304-18	Strength of Materials-I	4
4	BTME305-18	Basic Thermodynamics	4
5	BTME501-18	Heat Transfer	4

Elective Subject (Even Semester)

Sr. No.	Subject Code	Couse Title	Credits
1	BTME603-18	Automobile Engineering	4
2	BTME405-18	Theory of Machines-II	4
3	BTME403-18	Strength of Materials-II	4
4	BTME401-18	Applied Thermodynamics	4
5	BTME601-18	Refrigeration and Air Conditioning	4

BTME301-18 FLUID MECHANICS

Course Outcomes:

After studying this course, students will be able to:

1. Understand the concept of fluids and their properties.
2. Apply the concept to solve the problems related to statics, dynamics and kinematics of fluids.
3. Use and apply dimensional analysis and similitude techniques to various physical fluid phenomena.
4. Distinguish various types of flows and learn flow measurement methods.

Detailed Contents:

1. **Fundamentals of Fluid Mechanics**: Introduction; Applications; Concept of fluid; Difference between solids, liquids and gases; Concept of continuum; Ideal and real fluids; Fluid properties: density, specific volume, specific weight, specific gravity, viscosity (dynamic and kinematic), vapour pressure, compressibility, bulk modulus, Mach number, surface tension and capillarity; Newtonian and non-Newtonian fluids. **02 Hrs**

2. **Fluid Statics:** Concept of static fluid pressure; Pascal's law and its engineering applications; Hydrostatic paradox; Action of fluid pressure on a plane submerged surface (horizontal, vertical and inclined): resultant force and centre of pressure; Force on a curved surface due to hydrostatic pressure; Buoyancy and flotation; Stability of floating and submerged bodies; Metacentric height and its determination; Periodic time of oscillation; Pressure distribution in a liquid subject to: (i) constant acceleration along horizontal, vertical and inclined direction (linear motion), (ii) constant rotation. **06 Hrs**

3. **Fluid Kinematics:** Classification of fluid flows; Lagrangian and Euler flow descriptions; Velocity and acceleration of fluid particle; Local and convective acceleration; Normal and tangential acceleration; Path line, streak line, streamline and timelines; Flow rate and discharge mean velocity; One dimensional continuity equation; Continuity equation in Cartesian (x,y,z), polar (r,θ) and cylindrical (r,θ,z) coordinates; Derivation of continuity equation using the Lagrangian method in Cartesian coordinates; Rotational flows: rotation, vorticity and circulation; Stream function and velocity potential function, and relationship between them; Flow net. **07 Hrs**

4. **Fluid Dynamics:** Derivation of Euler's equation of motion in Cartesian coordinates, and along a streamline; Derivation of Bernoulli's equation using principle of conservation of energy and equation of motionand its applications to steady state ideal and real fluid flows; Representation of energy changes in fluid system (hydraulic and energy gradient lines); Impulse momentum equation; Kinetic energy and momentum correction factors; Flow along a curved streamline; Free and forced vortex motions. **07 Hrs**

5. Dimensional Analysis and Similitude: Need of dimensional analysis; Fundamental and derived units; Dimensions and dimensional homogeneity; Rayleigh's and Buckingham's π - method for dimensional analysis; Dimensionless numbers (Reynolds, Froude, Euler, Mach, and Weber) and their significance; Need of similitude; Geometric, kinematic and dynamic similarity; Model and prototype studies; Similarity model laws. **04 Hrs**

6. Internal Flows: Laminar and Turbulent Flows: Reynolds number, critical velocity, critical Reynolds number, hydraulic diameter, flow regimes; Hagen – Poiseuille equation; Darcy equation; Head losses in pipes and pipe fittings; Flow through pipes in series and parallel; Concept of equivalent pipe; Roughness in pipes, Moody's chart. **06 Hrs**

7. Pressure and Flow Measurement: Manometers; Pitot tubes; Various hydraulic coefficients; Orifice meters; Venturi meters; Borda mouthpieces; Notches (rectangular, V and Trapezoidal) and weirs; Rotameters. **04 Hrs**

Suggested Readings / Books:

1. S.K. Som, G. Biswas and S. Chakraborty, "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw Hill Publications, 3rd edition, 2011.
2. D.S. Kumar, "Fluid Mechanics and Fluid Power Engineering", S.K. Kataria and Sons Publishers, 1st Edition, 2009.
3. C.S.P. Ojha, R. Berndtsson and P.N. Chandramouli, "Fluid Mechanics and Machinery", Oxford University Press,1st Edition, 2010.
4. Y.A. Cengel and J.M. Cimbala, "Fluid Mechanics - Fundamentals and Applications", Tata McGraw Hill Publications, 3rd Edition, 2013.
5. V.L. Streeter, E.B. Wylie and K.W. Bedford, "Fluid Mechanics", McGraw Hill BookCompany, New York, 9th Edition, 1998.
6. Frank M. White, "Fluid Mechanics", Tata Mc Graw Hill Publications, 5th Edition, 2012.

BTME302-18 THEORY OF MACHINES -I

Course Outcomes:

After studying this course, students will be able to:

1. Understand constructional and working features of important machine elements.
2. Design belt, rope and chain drives for transmission of motion from one shaft to another.
3. Identify different Cam and follower pairs for different applications and construct cam profile for required follower motion.
4. Understand the function of brakes, dynamometers, flywheel and governors.

Detailed Contents:

1. Basic Concept of machines: Link, Mechanism, Kinematic Pair and Kinematic Chain, Principles of Inversion, Inversion of a Four Bar Chain, Slider-Crank-Chain and Double Slider-Crank-Chain. Graphical and Analytical methods for finding: Displacement, Velocity, and Acceleration of mechanisms including Corliolis Components. **06 Hrs**

2. Lower and higher Pairs: Universal Joint, Calculation of maximum Torque, Steering Mechanisms including Ackerman and Davis approximate steering mechanism, Engine Indicator, Pentograph, Straight Line Mechanisms, Introduction to Higher Pairs with examples. **05 Hrs**

3. Belts, Ropes and Chains: Material & Types of belt, Flat and V-belts, Rope & Chain Drives, Idle Pulley, Intermediate or Counter Shaft Pulley, Angle and Right Angle Drive, Quarter Turn Drive, Velocity Ratio, Crowning of Pulley, Loose and fast pulley, stepped or cone pulleys, ratio of tension on tight and slack side of belts, Length of belt, Power transmitted by belts including consideration of Creep and Slip, Centrifugal Tensions and its effect on power transmission. **05 Hrs**

4. Cams: Types of cams and follower, definitions of terms connected with cams. Displacement,velocity and acceleration diagrams for cam followers. Analytical and Graphical design of camprofiles with various motions (SHM, uniform velocity, uniform acceleration and retardation,cycloidal Motion). Analysis of follower motion for circular, convex and tangent cam profiles. **05 Hrs**

5. Friction Devices: Concepts of friction and wear related to bearing and clutches. Types of brakes function of brakes. Braking of front and rear tyres of a vehicle. Determination of braking capacity, Types of dynamometers, (absorption, and transmission). **06 Hrs**

6. Flywheels: Turning moment and crank effort diagrams for reciprocating machines' Fluctuations of speed, coefficient of fluctuation of speed and energy, Determination of mass and dimensions of flywheel used for engines and punching machines. **03 Hrs**

7. Governors: Function, types and characteristics of governors. Watt, Porter and Proell governors. Hartnell and Willson-Hartnell spring loaded governors. Numerical problems related to these governors. Sensitivity, stability, isochronisms and hunting of governors. Governor effort and power, controlling force curve, effect of sleeve friction. **06 Hrs**

Suggested Readings / Books:

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

BTME303-18 MACHINE DRAWING

Course Outcomes:

After studying this course; the student will be able to:

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

Note:

1. Drawing Practice is to be done as per IS code SP 46:2003 by Bureau of Indian Standards.
2. The Question paper shall have following structure/weightage:
   Section A – Short answer type Questions based upon whole syllabus – 10 question of 02 marks each (All questions are compulsory).
   Section B – Free hand sketching of machine parts etc.; – out of 03 questions of 05 marks each, 02 Questions are to be attempted.
   Section C – Assembly drawing (from Unit-III) of machine parts with at least two views (with bill of materials) – out of 02 questions of 30 marks each;01 question is to be attempted.

Detailed Contents:

1. Introduction: Classification of drawings, Principles of drawing, Requirements of machine Drawing, sectional views and conventional representation, dimensioning, concept of limits, fits & tolerances and their representation, machining symbols, various types of screw threads, types of nuts and bolts, screw fasteners, welded joints and riveted joints, introduction and familiarization of code SP 46:2003 by Bureau of Indian Standards. **15 Hrs**

2. Free hand sketches of:

a. **Couplings**: solid and rigid couplings, protected type flange coupling, pin type flexible coupling, muff coupling.
b. Knuckle and cotter joints.
c. **Pipe and Pipe fittings**: Flanged joints, spigot and socket joint, union joint, hydraulic and expansion joint. **15 Hrs**

3. Assembly of:

a. **IC Engine Parts:** piston and connecting rod.
b. **Boiler Mountings**: Steam stop valve, blow off cock, feed check valve and spring loaded safety valve.
c. **Bearing:** Swivel bearing, Plummer Block and Foot Step bearing.
d. **Miscellaneous:** Screw jack, Tail Stock and crane hook. **20 Hrs**

4. Practice using Computer Aided Drafting (CAD) tools for:

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

(b) Assemblies: - Bearings (Plumber Block, Footstep, Swivel), boiler mountings, screw jack, Exercise in computer Plots of drawing

(c) Case studies in computer plots and industrial blueprint **10 Hrs**

Suggested Reading/Books:

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

Topic for Self-Learning (TSL)

1.Conventional representation of common feature like Springs, Gear Assembly, Braking of shaft, Pipe, Screw threads etc.
2.Drawing of special Types of bolts, nuts and washers.
3.Importance of bill of materials (BOM)
4.Free hand sketch of bearings (i.e. ball bearing and roller bearing).

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BTME304-18 STRENGTH OF MATERIALS-I

Course Outcomes:

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

1. Understand the concepts of stress and strain at a point, in the members subjected to axial, bending, torsional loads and temperature changes.
2. Determine principal stresses, maximum shearing stress and their angles, and the stresses acting on any arbitrary plane within a structural element.
3. Find bending moment and shear force over the span of various beams subjected to different kinds of loads.
4. Calculate load carrying capacity of columns and struts and their buckling strength.
5. Evaluate the slope and deflection of beams subjected to loads.

Detailed Contents:

1.Simple, Compound Stresses and Strains: Stress and Strain and their types, Hook's law, longitudinal and lateral strain, Poisson's ratio, stress-strain diagram for ductile and brittle materials, extension of a bar due to without and with self weight, bar of uniform strength, stress in a bar, elastic constants and their significance, relation between elastic constants, Young's modulus of elasticity, modulus of rigidity and bulk modulus. Temperature stress and strain calculation due to axial load and variation of temperature in single and compound bars. Two-dimensional stress system, stress at a point on a plane, principal stresses and principal planes, Mohr's circle of stress. Generalized Hook's law, principal stresses related to principal strains. **08 Hrs**

2.Bending Moment (B.M) and Shear Force (S.F) Diagrams: S.F and B.M definitions; relation between load, shear force and bending moment; B.M and S.F diagrams for cantilevers, simply supported beams with or without overhangs, and calculation of maximum B.M and S.F and the point of contra flexure under different loads: Concentrated loads, Uniformity distributed loads over the whole span or part of span, Combination of concentrated and uniformly distributed load, Uniformly varying loads and Application of moments. **06 Hrs**

3.Bending Stresses in Beams: Assumptions in the simple bending theory; derivation of formula and its application to beams of rectangular, circular and channel, I and T- sections. Combined direct and bending stresses in afore-mentioned sections, composite / flitched beams. **05 Hrs**

4.Torsion: Derivation of torsion equation and its assumptions and its application to the hollow and solid circular shafts. Torsional rigidity, combined torsion and bending of circular shafts; principal stress and maximum shear stresses under combined loading of bending and torsion. **05 Hrs**

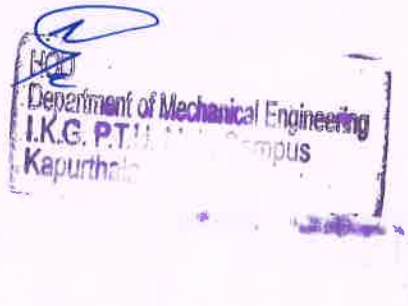
5.Columns and struts: Introduction, failure of columns, Euler's formula, Rankine-Gordon's formula, Johnson's empirical formula for axially loaded columns and their applications.

05 Hrs

6.Slope and deflection: Relationship between moment, slope and deflection; method of integration, Macaulay's method, moment area method and use of these methods to calculate slope and deflection for: Cantilevers, Simply supported beams with or without overhang, Under concentrated loads, uniformly distributed loads or combination of concentrated &uniformly distributed loads. **07 Hrs**

Suggested Readings/Books:

1. Timoshenko and Gere, "Mechanics of Materials", CBS Publishers and Distributors, New Delhi.
2. Pytel&Kiusalaas, "Mechanics of Materials", Cengage Learning, New Delhi.
3. S. S. Rattan, "Strength of Materials", Tata McGraw Hill, New Delhi.
4. R. K. Bansal, "A Text Book of Strength of Materials", Laxmi Publications, New Delhi.
5. D. K. Singh, "Strength of Materials", Ane Books Pvt. Ltd., New Delhi.
6. Sadhu Singh, Strength of Materials, Khanna Publishers, Delhi.



BTEC305-18 BASIC ELECTRONICS ENGINEERING

Course Objectives:

The objective of this Course is to provide the students of B.Tech Mechanical Engineering with an introductory and broad treatment of the field of Electronics Engineering to facilitate better understanding of the basic Electronics devices.

Course Outcomes:

After undergoing this course students will be able to

1. Understand construction of diodes and their rectifier applications.
2. Appreciate the construction and working bipolar junction transistors and MOSFETs.
3. Design Op-Amp IC based fundamental applications.
4. Comprehend working of basic elements of digital electronics and circuits.

Unit I: Semiconductor Diodes and Applications - Semiconductor Diode - Ideal versus Practical, Diode as a Rectifier, Half Wave and Full Wave Rectifiers with and without Filters; Breakdown Mechanisms, Zener Diode – Operation and Applications; Opto-Electronic Devices – LEDs, Photo Diode and Applications;

Unit II: Transistors & Amplifiers - Bipolar Junction Transistor (BJT) – Construction, Operation, Common Base, Common Emitter and Common Collector Configurations, Distortion, Operating Point, Voltage Divider Bias Configuration; Introduction to nMOS and pMOS.

Unit III: Operational Amplifiers and Applications - Introduction to Op-Amp, Block Diagram, Pin Configuration of 741 Op-Amp, Characteristics of Ideal Op-Amp, Concept of Virtual Ground, Op-Amp Applications – Adder, Subtractor, Voltage Follower and Comparator; Differentiator and Integrator, Square Wave and Triangular Wave Generation.

Unit IV: Digital Electronics -Boolean Algebra - Binary, Octal, Hexadecimal Number Systems, Addition, Subtraction using 1's and 2's compliment method, Logic Gates – NOT, OR, AND, NOR, NAND, XOR and XNOR Integrated Circuits (ICs); K-Map simplification Truth Tables and Functionality of Flip-Flops – SR, JK and D Flip-Flop.

Text/Reference Books:

2. David. A. Bell (2003), Laboratory Manual for Electronic Devices and Circuits, Prentice Hall, India.
3. SantiramKal (2002), Basic Electronics- Devices, Circuits and IT Fundamentals, Prentice Hall, India.
4. Thomas L. Floyd and R. P. Jain (2009), Digital Fundamentals by Pearson Education.
5. Paul B. Zbar, A.P. Malvino and M.A. Miller (2009), Basic Electronics – A Text-Lab. Manual, TMH
6. R. T. Paynter (2009), Introductory Electronic Devices & Circuits, Conventional Flow Version, Pearson.

BTME305-18 BASIC THERMODYNAMICS

Course Objectives:

The course has been designed to cover the interconversion of heat energy into work energy and vice versa; balance of energy between the System and its Surroundings; to learn about the application of First and Second law to various thermodynamic Systems, to learn about gas power cycles and IC Engines, to learn about steam formation and its properties, to learn about vapor power cycles.

Course Outcomes:

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

1. Basic Concepts

Definition of thermodynamics, Concept of Thermodynamic System and of thermodynamic equilibrium, Boundary and Surroundings; Open, Closed and Isolated Systems. Property, state, path, process and cycle; dot/point functions and path functions, Phase and pure substances, Equation of State, reversible, Quasi-static and irreversible processes; Energy and its forms, Energy transfer across the System boundaries. Types of work transfer, heat and work; sign conventions for heat and work interaction, Concept of temperature and heat, microscopic and macroscopic approach, Concept of continuum, Zeroth law of thermodynamics. Concept of thermal equilibrium and principles of thermometry. Ideal gas and characteristic gas equation. (4)

2. First Law of Thermodynamics

Concept of First law of thermodynamics, essence and corollaries of First law; internal energy and enthalpy, analysis of non flow and flow processes for an ideal gas for constant volume(*isochoric*), constant pressure(*isobaric*), constant temperature(*isothermal*), adiabatic and polytropic processes. Changes in various properties, work done and heat exchange during these processes, free expansion and throtting process and its applications in Engineering processes; Steady Flow Energy Equation and its application to various thermodynamic Systems(ie, in *engineering devices*); (8)

3. Second Law of Thermodynamics

Limitations of First law of thermodynamics, concept of Kelvin Plank and Clausius statements of the Second law and their ***equivalence*** *and* their application *to Refrigerator, Heat Pump and Heat Engine*. Thermodynamic temperature scale, Efficiency and philosophy of Carnot cycle and its consequences, Carnot Engine and Carnot theorem; Carnot refrigerator, Heat Pump and Heat Engines. Clausius theorem; Clausius inequality; concept of entropy, principle

of increase in entropy, representation of various processes on T-S coordinates and change in entropy for different processes, concept of entropy generation in Closed and Open systems, high grade and low grade energy, available and unavailable energy; availability and unavailability, Second law efficiency and energy analysis of Thermodynamic Systems, Third law of Thermodynamics (definition only). (8)

4. Gas Power Cycles

Air-standard efficiency, Nomenclature of Piston-Cylinder arrangement w.r.t. swept volume; clearance volume, compression ratio and mean effective pressure; Analysis and philosophy of Air-Standard Cycles i.e. Otto Cycle, Diesel Cycle and Dual Cycle; their compression ratio, mean effective pressure, power output and Efficiency; Comparison between the three Cycles. (9)

5. Internal Combustion Engines

Classification and application, constructional and working details of two stroke and four stroke cycle engines.

6. Properties of Steam

Pure Substance; steam formation at constant pressure and the properties of steam; use of steam tables, constant volume, constant pressure and isentropic process, simple Ranking cycle. Construction, working, classification and applications of gas turbines, comparison of gas turbines with steam turbines and IC engines, performance analysis of constant pressure gas turbine cycle (Brayton cycle), thermal refinements like regeneration, inter-cooling and re-heating, selection

Suggested Books:

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

BTME306-18 Strength of Material Lab

Course Outcomes:

After studying this course, students shall be able to:

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

List of Practical

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

BTME307-18 Theory of Machine (Lab)

Course Outcomes:

After studying this course, students shall be able to:

1. Determine gyroscopic couple, balancing of rotating masses and Cam profile analysis.
2. Determine gear- train value of compound gear trains and epicyclic gear trains.

List of Practical

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

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Kapurthala

BTME308-18 Fluid Mechanics (Lab)

Course Outcomes:

After studying this course, students shall be able to:

1. Distinguish various type of flows and flow measurement methods and concept of statics and dynamics of liquids.
2. Determine discharge and head loss, hydraulic and friction coefficient, for different types of flow in pipe and open channels.

List of Practical

1. To determine the metacentric height of a floating vessel under loaded and unloaded conditions.
2. To study the flow through a variable area duct and verify Bernoulli's energy equation.
3. To determine the coefficient of discharge for an obstruction flow meter (venturi meter/ orifice meter.
4. To determine the discharge coefficient for a V- notch or rectangular notch.
5. To study the transition from laminar to turbulent flow and to ascertain the lower critical Reynolds number.
6. To determine the hydraulic coefficients for flow through an orifice.
7. To determine the friction coefficients for pipes of different diameters.
8. To determine the head loss in a pipe line due to sudden expansion/ sudden contraction/ bend.
9. To determine the velocity distribution for pipeline flow with a pitot static probe.
10. Experimental evaluation of free and forced vortex flow

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Guidelines regarding Mentoring and Professional Development

The objective of mentoring will be development of:

- Overall Personality
- Aptitude (Technical and General)
- General Awareness (Current Affairs and GK)
- Communication Skills
- Presentation Skills

The course shall be split in two sections i.e. outdoor activities and class activities. For achieving the above, suggestive list of activities to be conducted are:

Part – A
(Class Activities)

1. Expert and video lectures
2. Aptitude Test
3. Group Discussion
4. Quiz (General/Technical)
5. Presentations by the students
6. Team building Exercises

Part – B
(Outdoor Activities)

1. Sports/NSS/NCC
2. Society Activities of various students chapter i.e. ISTE, SCIE, SAE, CSI, Cultural Club, etc.

Evaluation shall be based on rubrics for Part – A & B
Mentors/Faculty incharges shall maintain proper record student wise of each activity conducted and the same shall be submitted to the department.

BTME401-18 APPLIED THERMODYNAMICS

Course Outcomes:

After studying this course, students will be able to:

1. Learn the functioning and performance evaluation of reciprocating air compressors.
2. Analyze the combustion phenomenon in boilers and I.C. engines.
3. Use of Steam Tables and MollierChart to solve vapour power cycle problems.
4. Explain the constructional features and working of steam power plants and to evaluate their performance.

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

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

5 Hrs

3. Steam: Properties of Steam Pure substance ; Steam and its formation at constant pressure: wet, dry and super-heated(*super-saturated*) steam; Sensible heat*(sensible enthalpy)*, latent heat(*latent enthalpy*) and total/stagnation heat(*total/stagnation 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 Charts; Basic thermodynamic processes with steam(isochoric, isobaric, isothermal, isentropic and adiabatic processes) and their representation on T-S Charts and Mollier Charts(**h-s** diagrams), significance of Mollier Charts. **5 Hrs**

4. 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

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heating cycles. 5 Hrs

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

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

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

8. 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.
5 Hrs

Suggested Books:

1. R. Yadav, "Applied Thermodynamics", Central Publishing House , Allahabad.
2. D.S. Kumar and V.P. Vasandani, "Heat Engineering", Metropolitan Book Co. Pvt. Ltd.
3. G Rogers and Y.Mayhew , "Engineering Thermodynamics", Pearson, Wesley Longman (Singapore) Pte, 482 F.I.E Patparganj, Delhi-110 092.
4. W.A.J. Keartan, Steam Turbine: , "Theory and Practice", ELBS Series.
5. V. Ganeshan, "Internal Combustion Engines", Tata McGraw Hill Education Pvt. Ltd., 7 West Patel Nagar, New Delhi-110 008.
6. P.K.Nag, "Basic & Applied Thermodynamics", Tata McGraw Hill Education Pvt. Ltd., 7 West Patel Nagar, New Delhi-110 008.
7. P.K. Nag, "Engineering Thermodynamics", Tata McGraw Hill Education Pvt. Ltd., 7 West Patel Nagar, New Delhi-110 008.
8. E.F. Obert, "Concepts of Thermodynamics", Tata McGraw Hill Education Pvt. Ltd., 7 West Patel Nagar, New Delhi-110 008.
9. C.P. Arora, "Thermodynamics", Tata McGraw Hill Education Pvt. Ltd., 7 West Patel Nagar, New Delhi-110008.

BTME402-18 FLUID MACHINES

Course Outcomes:

After studying this course, students shall be able to:

1. Recognize basic components of turbo machines and understand related fundamental laws/ principles and apply these for calculation of various parameters like work done, force efficiency etc.
2. Know about constructional details, working and design aspects of runner/wheel and evaluate the performance of various turbines like Pelton, Kaplan and Francis.
3. Know about constructional details, working and evaluate the performance of centrifugal pump under different vane shape conditions.
4. Know about constructional details, working and evaluate the performance of reciprocating pump and evaluate the effect of various deviations from the ideal conditions on the work done.
5. Know about constructional details and working of hydraulic devices like fluid coupling, accumulator and intensifier.

Detailed 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. Euler's equation for energy transfer in a turbo machine and specifying the energy transfer in terms of fluid and rotor kinetic energy changes. **07 Hrs**

2. Pelton Turbine: Component parts and operation; velocity triangles; 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; governing of Pelton turbine. **05 Hrs**

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; governing of reaction turbines. **06 Hrs**

4. Centrifugal Pumps: Layout and installation; Main elements and their functions; Various types and classification; Pressure changes in a pump; Heads of a pump - suction; delivery; static; manometric; total; net positive suction head and Euler's head; 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; model testing and 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. **06 Hrs**

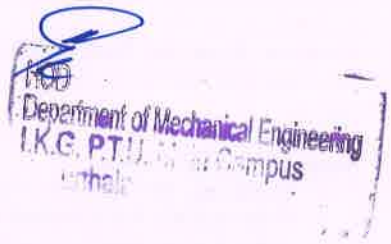
5. Similarity Relations and Performance Characteristics: Unit quantities; specific speed and model relationships; scale effect; Cavitation and Thomas's cavitation number; Concept of Net PositiveSuction Head (NPSH) and its application. **04 Hrs**

6. Reciprocating Pumps: Introduction to single acting and double acting reciprocating pumps; their components; and 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; Functions of Air vessels. **05 Hrs**

7. Hydraulic Devices and Systems: Construction; operation and utility of simple and differential accumulator; intensifier; fluid coupling and torque converter; Air lift and jet pumps; gear; vane and piston pumps; Hydraulic Ram; Hydraulic lift; Hydraulic crane and Hydraulic press. **03 Hrs**

Suggested Reading/ Books:

1. R.L. Daughaty, Hydraulic Turbines, McGraw Hill
2. Jagdish Lal, Hydraulic Machines by Metropolitan Book Co
3. D.S. Kumar, Fluid Mechanics and Fluid Power Engineering, SK Kataria and Sons,
4. K. Subramaniam, Hydraulic Machines, Tata Mc Graw Hill
5. R.K. Purohit., Hydraulic Machines, Scientific Publishers
6. C.S.P.Ojha, R.Berndtsson, P.Chandramouli, "Fluid Mechanics and Machinery", Oxford University Press, 2010



BTME403-18 STRENGTH OF MATERIALS II

Course Outcomes:

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

1. Apply the basics to find stresses in various applications (shells, curved beams and rotating discs).
2. Analyse the change in dimensions of shells, curved beams and rotating discs under operation.
3. Determine stresses, deflection and energy stored in various kinds of springs subjected to load and twist.
4. Understand the concept of failure theories and strain energy.
5. Evaluate shearing stress variation in beams of different cross-section and materials.

Detailed Contents:

1.Strain Energy: Introduction to strain energy, energy of dilation and distortion. Resilience, stress due to suddenly applied loads. Castigliano's and Maxwell's theorem of reciprocal deflection. **05 Hrs**

2.Theories of Failure: Maximum principal stress theory, maximum shear stress theory, maximum principal strain theory, total strain energy theory, shear strain energy theory. Graphical representation and derivation of equation for these theories and their application to problems related to two-dimensional stress systems. **05 Hrs**

3.Springs: Open and closed coiled helical springs under the action of axial load and/or couple. Flat spiral springs- derivation of formula for strain energy, maximum stress and rotation. Leaf spring deflection and bending stresses. **05 Hrs**

4.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. **05 Hrs**

5.Thick Cylinders: Derivation of Lame's equations, calculation of radial, longitudinal and hoop stresses and strains due to internal pressure in thick cylinders, compound cylinders, hub shrunk on solid shafts, shrinkage allowance and shrinkage stress. **05 Hrs**

6.Bending of Curved Beams: Calculation of stresses in cranes or chain hooks, rings of circular and trapezoidal section, and chain links with straight sides. **04 Hrs**

7.Shear Stresses in Beams: Shear stress distribution in rectangular, circular, I, T and channel section, built up beams. Shear centre and its importance. **04 Hrs**

8.Rotational Discs: Stresses in rotating discs and rims of uniform thickness; disc of uniform strength. **03 Hrs**

Suggested Readings/Books:

1. S. S. Rattan, "Strength of Materials", Tata McGraw Hill, New Delhi.
2. R. K. Bansal, "A Text Book of Strength of Materials", Laxmi Publications, New Delhi.
3. Sadhu Singh, Strength of Materials, Khanna Publishers, Delhi.
4. Kirpal Singh, "Mechanics of Materials", Standard Publishers, New Delhi.
5. R.S. Lehri, "Strength of Materials", Katson Publishers, New Delhi.

BTME404-18 MATERIALS ENGINEERING

Course Outcomes:

After studying this course, students shall be able to:

1. Understand the significance of structure-property-correlation for engineering materials including ferrous and nonferrous.
2. Explain the use and importance of various heat treatment processes used for engineering materials and their practical applications.
3. Understand the various structural changes occurred in metals with respect to time temperature transformations.
4. Understand the significance of Fe-C and TTT diagram for controlling the desired structure and properties of the materials.

Detailed Content:

1. Crystallography: Atomic structure of metals, atomic bonding in solids, crystal structures, crystallattice of body centered cubic, face centered cubic, closed packed hexagonal; crystalline and noncrystalline 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. **12 Hrs**

2. Phase Transformation: General principles of phase transformation in alloys, phase rule andequilibrium diagrams, Equilibrium diagrams of Binary systems. Iron carbon equilibrium diagramand various phase transformations. Time temperature transformation curves (TTT curves): fundamentals, construction and applications. **09 Hrs**

3. Heat Treatment: Principles and applications. Processes viz. annealing, normalizing, hardening, tempering. Surface hardening of steels: Principles of induction and oxyacetylene flame hardening.Procedure for carburising, nitriding and cyaniding. Harden-ability: determination of harden-ability.Jominy end-quench test. Defects due to heat treatment and their remedies; effects produced byalloying elements. Composition of alloy steels. **09 Hrs**

4. Ferrous Metals and Their Alloys: Introduction, classification, composition of alloys, effect ofalloying elements (Si, Mn, Ni, Cr, Mo, W, Al) on the structures and properties of steel. **06 Hrs**

Suggested Readings / Books:

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

BTME405-18 THEORY OF MACHINES-II

Course Outcomes:

After studying this course, students will be able to:

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

Detailed Contents:

1. Static force analysis: Concept of force and couple, free body diagram, condition of equilibrium, static equilibrium of mechanism, methods of static force analysis of simple mechanisms. Power transmission elements, considerations of frictional forces. **05 Hrs**

2. Dynamic force analysis Determination of forces and couples for a crank, inertia of reciprocating parts, dynamically equivalent system, analytical and graphical method, inertia force analysis of basic engine mechanism, torque required to overcome inertia and gravitational force of a four-bar linkage. **05 Hrs**

3. Balancing: Necessity of balancing, static and dynamic balancing, balancing of single and multiple rotating masses, partial unbalanced primary force in an engine, balancing of reciprocating masses,and condition of balance in multi cylinder in line V-engines, concept of direct and reverse crank, balancing of machines, rotors, reversible rotors. **06 Hrs**

4. Gears: Toothed gears, types of toothed gears and its terminology. Path of contact, arc of contact, conditions for correct gearing, forms of teeth, involutes and its variants, interference and methods of its removal. Calculation of minimum number of teeth on pinion/wheel for involute rack, helical, spiral, bevel and worm gears. Center distance for spiral gears and efficiency of spiral gears. **07 Hrs**

5. Gear Trains: Types of gear trains, simple, compound and epicyclic gear trains, problems involving their applications, estimation of velocity ratio of worm and worm wheel. **05 Hrs**

6. Gyroscopic motion and couples: Effect on supporting and holding structures of machines. stabilization of ships and planes, Gyroscopic effect on two and four wheeled vehicles. **03 Hrs**

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

Suggested Readings / Books:

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

BTME406-18 Applied Thermodynamics (Lab)

Course Outcomes:

After studying this course, students shall be able to:

1. Understand the construction and working of IC engines, and evaluate their performance.
2. Identify the various types of boilers & condensers.

List of Practical

1	Study of construction and operation of 2 stroke and 4 stroke Petrol and Diesel engines using actual engines or models.
2	To plot actual valve timing diagram of a 4 stroke petrol and diesel engines and study its impact on the performance of engine.Study of working, construction, mountings and accessories of various types of boilers.
3	Study of working, construction, mountings and accessories of various types of boilers.
4	To perform a boiler trial to estimate equivalent evaporation and efficiency of a fire tube/ water tube boiler.
5	Determination of dryness fraction of steam and estimation of brake power, Rankine efficiency, relative efficiency, generator efficiency, and overall efficiency of an impulse steam turbine and to plot a Willian's line.
6	Determine the brake power, indicated power, friction power and mechanical efficiency of a multi cylinder petrol engine running at constant speed (Morse Test).
7	Performance testing of a Petrol and Diesel engine from no load to full load (at constant speed) for a single cylinder/ multi- cylinder engine in terms of brake power, indicated power, mechanical efficiency and specific fuel consumption and to measure the exhaust emission. Draw/obtain power consumption and exhaust emission curves. Also make the heat balance sheet.
8	Performance testing of a petrol engine from no load to full load (at constant speed) for a single cylinder/ multi- cylinder engine in terms of brake power, indicated power, mechanical efficiency and specific fuel consumption and to measure the exhaust emissions. Also draw/obtain power consumption and exhaust emission curves.
9	Study of construction and operation of various types of steam condensers and cooling towers.

BTME407-18 Fluid Machines (Lab)

Course Outcomes:

After studying this course, students shall be able to:

1. Conduct experiments on scaled down models or on actual size hydraulic machines and evaluate results in terms of unit or specific quantities for comparison purpose.
2. Understand the working of various hydraulic machines (turbines and pumps) and can suggest remedial solutions for various faults.

List of Practical

1	Determination of various efficiencies of Hydraulic Ram
2	To draw characteristics of Francis turbine/Kaplan Turbine
3	To study the constructional features of reciprocating pump and to perform test on it for determination of pump performance
4	To draw the characteristics of Pelton Turbine
5	To draw the various characteristics of Centrifugal pump
6	Determine the effect of vane shape and vane angle on the performance of centrifugal fan/Blower
7	A visit to any Hydroelectric Power Station

BTME408-18 Material Engineering (Lab)

Course Outcomes:

After studying this course, students shall be able to:

1. Analyse the microstructure of different ferrous and non-ferrous samples.
2. Explore the effect of heat treatment on various engineering materials by analysing its microstructure and hardness.

List of Practical

1	Preparation of models/charts related to atomic/crystal structure of metals.
2	Annealing the steel specimen and study the effect of annealing time and temperature on hardness of steel. 3.3
3	Hardening the steel specimen and study the effect of quenching medium on hardness of steel.
4	Practice of specimen preparation (cutting, mounting, polishing, etching) of mild steel, Aluminium and hardened steel specimens.
5	Study of the microstructure of prepared specimens of Mild Steel, Aluminium and hardened steel.
6	Identification of ferrite and pearlite constituents in given specimen of milsteel.
7	Determination of hardenability of steel by Jominy End Quench Test.

Guidelines regarding Mentoring and Professional Development

The objective of mentoring will be development of:

- Overall Personality
- Aptitude (Technical and General)
- General Awareness (Current Affairs and GK)
- Communication Skills
- Presentation Skills

The course shall be split in two sections i.e. outdoor activities and class activities. For achieving the above, suggestive list of activities to be conducted are:

Part – A
(Class Activities)

1. Expert and video lectures
2. Aptitude Test
3. Group Discussion
4. Quiz (General/Technical)
5. Presentations by the students
6. Team building Exercises

Part – B
(Outdoor Activities)

3. Sports/NSS/NCC
4. Society Activities of various students chapter i.e. ISTE, SCIE, SAE, CSI, Cultural Club, etc.

Evaluation shall be based on rubrics for Part – A & B
Mentors/Faculty incharges shall maintain proper record student wise of each activity conducted and the same shall be submitted to the department.

ENVIRONMENTAL STUDIES FOR B.TECH CIVIL, ELECTRONICS, ELECTRICAL ENGINEERING, MECHANICAL AND COMPUTER SCIENCE

Sl. No.	Category	Course Code	Course Title	Hours per week			Total contact hrs.	Credits
				Lecture	Tutorial	Practical		
1	Mandatory Non-credit Course	EVS101-18	Environmental Studies	2	0	0	21	0

*** 40 Hours are kept for various activities under the head of activities. There will be a final theory examination for the students of 50 marks but these marks will not be added to their final result as assessment will be satisfactory or non-satisfactory.**

Course Outcomes:

1. Students will enable to understand environmental problems at local and national level through literature and general awareness.
2. The students will gain practical knowledge by visiting wildlife areas, environmental institutes and various personalities who have done practical work on various environmental Issues.
3. The students will apply interdisciplinary approach to understand key environmental issues and critically analyze them to explore the possibilities to mitigate these problems.
4. Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world

Environmental Studies [L:2; T:0; P:0 (Credits-0)]

1. Environment Science (Mandatory non-credit course)

We as human being are not an entity separate from the environment around us rather we are a constituent seamlessly integrated and co-exist with the environment around us. We are not an entity so separate from the environment that we can think of mastering and controlling it rather we must understand that each and every action of ours reflects on the environment and vice versa. Ancient wisdom drawn from Vedas about environment and its sustenance reflects these ethos. There is a direct application of this wisdom even in modern times. Idea of an activity based course on environment protection is to sensitize the students.

Detailed Contents

Module 1 : Natural Resources :Renewable and non-renewable resources

Natural resources and associated problems.

a) Forest resources : Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.

b) Water resources : Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.

c) Mineral resources : Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

d) Food resources : World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

e) Energy resources : Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies.

f) Land resources : Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

- Role of an individual in conservation of natural resources.
- Equitable use of resoureces for sustainable lifestyles.

Module 2 : Ecosystems

Concept of an ecosystem. Structure and function of an ecosystem.
Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of following ecosystems:

a. Forest ecosystem
b. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Module 3 : Biodiversity and its conservation

- Introduction – Definition : genetic, species and ecosystem diversity.
- Biodiversity at global, National and local levels.
- Inida as a mega-diversity nation
- Hot-sports of biodiversity.
- Threats to biodiversity : habitat loss, poaching of wildlife, man-wildlife conflicts.
- Endangered and endemic species of India

Module 4 : Social Issues and the Environment

- From Unsustainable to Sustainable development
- Resettlement and rahabilitation of people; its problems and concerns.
- Environmental ethics : Issues and possible solutions.
- Climate change, global warming, acid rain, ozone layer depletion,

  Nuclear accidents and holocaust. Case Studies.
- Public awareness.

***ACTIVITIES**

Nature club (bird watching, recognizing plants at institute/at home, recognizing local animals, appreciating biodiversity

Impart knowledge and inculcate the habit of taking interest and understanding biodiversity in and around the college campus. The students should be encouraged to take interest in bird watching, recognizing local plants, herbs and local animals. The students should be encouraged to appreciate the difference in the local biodiversity in their hometown, in the place of their study and other places they visit for vacation/breaks etc.

Following activities must be included.

Identify a tree fruit flower peculiar to a place or having origin from the place.

Making high resolution big photographs of small creatures (bees, spiders, ants. mosquitos etc.) especially part of body so that people can recognize (games on recognizing animals/plants).

Videography/ photography/ information collections on specialties/unique features of different types of common creatures.

Search and explore patents and rights related to animals, trees etc. Studying miracles of mechanisms of different body systems.

1 *(A) Awareness Activities:*

a) Small group meetings about water management, promotion of recycle use, generation of less waste, avoiding electricity waste
b) Slogan making event
c) Poster making event
d) Cycle rally
e) Lectures from experts
f) Plantation
g) Gifting a tree to see its full growth
h) Cleanliness drive
i) To live with some eminent environmentalist for a week or so to understand his work vi) To work in kitchen garden for mess
j) To know about the different varieties of plants
k) Shutting down the fans and ACs of the campus for an hour or so
l) Visit to a local area to document environmental assets

river/forest/grassland/hill/mountain/lake/Estuary/Wetlands

m) Visit to a local polluted site-Urban/Rural/Industrial/Agricultural
n) Visit to a Wildlife sanctuary, Pushpa Gujral Science City, Kapurthala, National Park or Biosphere Reserve

Suggested Readings

1. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India, Email:mapin@icenet.net (R)
3. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p
4. Clark R.S., Marine Pollution, Clanderson Press Oxford (TB)

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5. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumabai, 1196p
6. Hawkins R.E., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R)
7. Heywood, V.H & Waston, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ. Press 1140p.
8. Mhaskar A.K., Matter Hazardous, Techno-Science Publication (TB)
9. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB)
10. Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA, 574p
11. Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science (TB)
12. Trivedi R.K., Handbook of Environmental Laws, Rules Guidelines, Compliances and Stadards, Vol I and II, Enviro Media (R)
13. Trivedi R. K. and P.K. Goel, Introduction to air pollution, Techno-Science Publication (TB)
14. Wanger K.D., 1998 Environmental Management. W.B. Saunders Co. Philadelphia, USA 499p.

BTME501-18 HEAT TRANSFER

Course objectives:
To provide knowledge about application of conduction, convection and radiation heat transfer concepts to different practical applications

Course Outcomes:

1. To teach students the basic principles of conduction, radiation, and convection heat transfer. Students will demonstrate an understanding of the basic concepts of conduction, radiation, and convection heat transfer.
2. To extend the basic principle of conservation of energy to systems that involve conduction, radiation, and heat transfer. Students will demonstrate an understanding of the concept of conservation of energy and its application to problems involving conduction, radiation, and/or convection heat transfer. This principle will be used to formulate appropriate mathematical models and associated thermal boundary conditions.
3. To train students to identify, formulate, and solve engineering problems involving conduction heat transfer. Students will demonstrate the ability to formulate practical conduction heat transfer problems by transforming the physical system into a mathematical model, selecting an appropriate solution technique, and evaluating the significance of results.
4. To train students to identify, formulate, and solve engineering problems involving forced convection heat transfer, natural convection heat transfer, and heat exchangers. Students will demonstrate the ability to formulate practical forced and natural conduction heat transfer problems by transforming the physical system into a mathematical model, selecting an appropriate solution technique, and evaluating the significance of results. Students will also demonstrate an ability to analyze the performance of heat exchangers
5. To train students to identify, formulate, and solve engineering problems involving radiation heat transfer among black surfaces and among diffuse gray surfaces. Students will demonstrate the ability to formulate practical radiation heat transfer problems by transforming the physical system into a mathematical model, selecting an appropriate solution technique, and evaluating the significance of results.

Detailed Contents:

Unit-I

Introduction to Heat Transfer: Thermodynamics and Heat Transfer. Modes of Heat Transfer: Conduction, convection and radiation. Effect of temperature on thermal conductivity of materials; Introduction to combined heat transfer mechanism.

Conduction: Fourier's law of heat conduction. Coefficient of thermal conductivity. Effect of temperature and pressure on thermal conductivity of solids, liquids and gases. Three-dimensional general conduction equations in rectangular, cylindrical and spherical coordinates.

Steady State one-dimensional Heat conduction-I: Deduction of one-dimensional steady state heat conduction equation in rectangular; cylindrical and spherical coordinates with and without internal heat generation for uniform thermal conductivity of material. Concept of variable thermal conductivity.

Steady State one-dimensional Heat conduction-II: Electrical network analysis for heat transfer through composite/multilayer material. Application of heat conduction with internal heat generation in case of piston crown and in nuclear fuel rod with/ without cladding. Concept of equivalent area. Conduction shape factor. Conduction through edges and corners of walls. Critical thickness of insulation layers on electric wires and pipes carrying hot fluids.

Unit-II

One Dimensional Transient Conduction Heat Transfer: Systems with negligible internal resistance – Significance of Biot and Fourier Numbers –Infinite bodies- Chart solutions of transient conduction systems- Concept of Semi-infinite body.

Theory of Fins: Concept of fin. Classification of fins and their applications. Straight fins of uniform cross-section. Individual and total fin effectiveness and efficiency. Application of fins in temperature measurement of flow through pipes and determination of error in its measurement.

Unit-III

Convection: Classification of systems based on causation of flow, condition of flow, configuration of flow and

medium of flow. Dimensional analysis as a tool for experimental investigation. Buckingham Pi Theorem ar method. Application for developing semi-empirical, non- dimensional correlation for convection heat transfe Significance of non-dimensional numbers. Concepts of continuity, momentum and energy Equations.

Forced convection: External Flows: Concepts about hydrodynamic and thermal boundary layer and use empirical correlations for convective heat transfer. -Flat plates and Cylinders. Internal Flows: Concepts abo Hydrodynamic and Thermal Entry Lengths Division of internal flow based on this Use of empirical relations f Horizontal Pipe Flow and annulus flow.

Natural Convection: Physical mechanism of natural convection. Buoyant force. Empirical heat transfer relatio for natural convection over vertical planes and cylinders, horizontal plates and cylinders, and sphere. Combined fr and forced convection

Unit-IV

Heat Exchanger: Types of heat exchangers; Fouling factors; Overall heat transfer coefficient; Logarithmic me temperature difference (LMTD) method; Effectiveness-NTU method; Compact heat exchangers. 3 **Condensati and Boiling** Boiling: Definition and types of boiling. Different regimes and heat transfer during pool boiling o liquid. Nucleation and different theories accounting for increased heat transfer coefficient during nucleate phase boiling. Condensation: Definition and types of condensation, film wise condensation on a vertical and inclin surface.

UNIT-V

Thermal Radiation: Process of heat flow due to radiation. Definition of emissivity, absorptivity, reflectivity a transmissivity. Concept of black and grey bodies. Plank's law of non chromatic radiation. Wien's displacement la Kirchoff's law. Stefan Boltzmann's law. Lambert's Cosine law. Definition of intensity of Radiation, irradiation a radiosity. Geometric/ configuration factor and its use in heat exchange between two black bodies. Electrical netwo analysis for radiation exchange between two, three or four bodies (e.g. boiler or other furnaces). Simplification electrical network analysis for its application to simple bodies like two parallel surfaces, concent cylinders/spheres and a body enveloped by another body. Use of radiation shields.

Text/Reference Books: 1. Incropera F.P. and De Witt D.P., "Fundamentals of Heat and Mass transfer", John Wil 7th Edition, 2011.
2. Cengel, A. Yunus, "Heat and Mass Transfer", Tata McGraw Hills Education Private Ltd, 4 th Edition, 2013.
3. Kumar, D.S. "Fundamentals of Heat and Mass Transfer", S K Kataria & Sons, 7th Edition, 2013.
4. Chapman. A. J, "Heat Transfer", McGraw Hill, 7th Edition, 1990.
5. Holman, J.P. "Heat Transfer", Tata McGraw-Hill Publishing Company Ltd, 9th Edition, 2008.

BTME502-18 DESIGN OF MACHINE ELEMENTS

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

Course Outcomes:

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

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

Detailed Contents:

Introduction

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

Design for Fatigue

Soderberg, Goodman and Gerber design Criteria

Design of shaft

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

Design of Bearings

Slider: Principle of hydrodynamic lubrication, modes of lubrication, bearing performance parameters, slider bearing design.

Roller: Types, selection guidelines, static and dynamic load carrying capacity, Stribeck's equation, equivalent bearing load, load life relationship.

Design of Transmission Drives

Belt drives: Design of Flat belt, V-belt, Design of the pulley for the same. Chain Drives: Roller chains, polygonal effect, power rating. Selection from the manufacturer's catalogue.

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.

Design of Springs

Design of springs: helical compression, tension, torsional and leaf springs

Design of clutches and brakes

Design of contact clutches i.e. plate, multi-disc, cone and centrifugal clutches, Design of band, disc, blo

with shoe and internal expanding brakes.

Design of joints: Threaded fasteners, pre-loaded bolts and welded joints.

Design, Analysis and Applications of Power screws and flexible coupling.

Books

1. Joseph E. Shigley, Charles Russell Mischke, Richard Gordon Budynas, Mechanical Engineering Design, McGraw-Hill
2. Robert L. Norton, Machine Design; An Integrating Approach, Pearson Publication.
3. Robert C. Juvinall Fundamentals of machine component design, JohnWiley Eastern
4. V.K Jadon, Analysis and design of machine elements, I.K. International
5. V.B Bhandari, Design of Machine elements, Tata Mc-Graw. Hill

Note: Design Data book is allowed in Examination.

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BTME503-18 MANUFACTURING PROCESSES

Course objectives:

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

Course Outcomes:

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

Detailed Contents:

Unit -1 Conventional Manufacturing Processes:

Casting and moulding: Metal casting processes and equipment, Heat transfer and solidification, shrinkage, riser design, casting defects and residual stresses.

Introduction to bulk and sheet metal forming, plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk forming (forging, rolling, extrusion, drawing) and sheet forming (shearing, deep drawing, bending) principles of powder metallurgy.

Metal cutting: Single and multi-point cutting; Orthogonal cutting, various force components: Chip formation, Tool wear and tool life, Surface finish and integrity, Machinability, Cutting tool materials, Cutting fluids, Coating; Turning, Drilling, Milling and finishing processes, Introduction to CNC machining.

Unit II: Additive manufacturing:

Rapid prototyping and rapid tooling

Unit III: Joining/fastening processes:

Physics of welding, brazing and soldering; design considerations in welding, Solid and liquid state joining processes; Adhesive bonding.

Unit IV Unconventional Machining Processes:

Unconventional Machining Processes: Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ultrasonic Machining, principles and process parameters.

Electrical Discharge Machining, principle and processes parameters, MRR, surface finish, tool wear, dielectric, power and control circuits, wire EDM; Electro-chemical machining (ECM), etchant &maskant, process parameters, MRR and surface finish. Laser Beam Machining (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining

Unit V Tooling

Tooling for conventional and non-conventional machining processes: Mould and die design, Press tools, Cutting tools; Holding tools: Jigs and fixtures, principles, applications and design; press tools – configuration, design of die and punch; principles of forging die design.

Text/Reference Books:

1. Rao P N, Manufacturing Technology, Foundry, Forming & Welding, Tata McGraw Hill.
2. Kalpakjian S and Steven R. Schmid, Manufacturing Engineering and Technology, Pearson Publishers.
3. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems
4. Degarmo, Black &Kohser, Materials and Processes in Manufacturing
5. Ghosh A, & Mallik A K 1986. Manufacturing science: Ellis Horwood.
6. Campbell J S, Principles of manufacturing materials and processes: Tata McGraw-Hill
7. Shan H S, Manufacturing Processes, Vol. I, Pearson Publishers.
8. Little, Welding and Welding Technology, McGraw-Hill Education (India) Pvt Ltd.
9. NPTEL courses, http://www.nptel.iitm.ac.in/courses.php?disciplineId=112 web and video resources on Manufacturing Processes I

BTME504-18 MANAGEMENT AND ENGINEERING ECONOMICS

Course objectives:

- Acquire knowledge of economics to facilitate the process of economic decision making
- Acquire knowledge on basic management aspects

Course Outcomes:

On completion of this subject students will be able to

6. Explain the development of management and the role it plays at different levels in an organization
7. Comprehend the process and role of effective planning, organizing and staffing for th development of an organization.
8. Understand the necessity of good leadership, communication and coordination for establishir effective control in an organization.
9. Understand engineering economics demand supply and its importance in economics decisi making and problem solving.
10. Calculate present worth, annual worth and IRR for different alternatives in economic decisi making.
11. Understand the procedure involved in estimation of cost for a simple component, product costi and depreciation, its methods.

Detailed Contents:

Unit-1: Management

Introduction: Meaning - nature and characteristics of Management, Scope and Functional areas management - Management as a science, art of profession - Management & Administration - Roles Management, Levels of Management, Development of Management Thought early manageme approaches – Modern management approaches.

Planning:

Nature, importance and purpose of planning process Objectives -Types of plans (Meaning Only)
Decision making Importance of planning -steps in planning & planning premises - Hierarchy of plans.

Unit-II: Organizing and Staffing

Nature and purpose of organization Principles of organization - Types of organization - Departmentati Committees- Centralization Vs Decentralization of authority and responsibility - Span of control - MI and MBE (Meaning Only) Nature and importance of staffing: Process of Selection & Recruitment brief).

Directing & Controlling:

Meaning and nature of directing Leadership styles, Motivation Theories, Communication - Meaning a importance - coordination, meaning and importance and Techniques of Co Ordination. Meaning and st in controlling - Essentials of a sound control system - Methods of establishing control (in brief)

Unit-III: Introduction

Engineering and economics, Problem solving and decision making, Laws of demand and supp Difference between Microeconomics & Macroeconomics, equilibrium between demand & supp elasticity of demand, price elasticity, income elasticity. Law of Returns, Interest and interest facto simple and compound interest, Cash flow diagrams, personal loans and EMI payment calculation w flexible interest rates, Discussion and problems

Unit-IV: Present, future and annual worth and rate of returns

Basic present worth comparisons, Present worth-equivalence, Assets with unequal lives and infinites liv future worth comparisons, payback comparisons, Equivalent annual worth comparisons, situations annual worth comparisons. Asset life, Rate of return, minimum acceptable rate of return, IRR anoma and misconceptions, Cost of capital, comparisons of all present future and annual worth with IRR, proc costing, Discussions and problems

Unit-V: Costing and Depreciation

Costing and depreciation:
Components of costs, estimation of selling price, marginal cost, first cost, all kinds of overheads, indirect cost estimation with depreciation, mensuration and estimation of material cost, cost estimation of mechanical process, idling time. Product costing (approaches to product costing), causes of depreciation, methods of computing depreciation charges, straight line method, declining balance method, sum of years method, sinking fund method, service output methods, taxation concepts, personal income taxes and corporate taxes, Discussions and problems.

Text Books:
1. Principles of Management by Tripathy and Reddy
2. Mechanical estimation and costing, T.R. Banga & S.C. Sharma, 17th edition 2015
3. Engineering Economy, Riggs J.L. McGraw Hill, 2002
4. Engineering Economy, Thuesen H.G. PHI , 2002

Reference Books:
1. Management Fundamentals- Concepts, Application, Skill Development - RobersLusier - Thomson
2. Basics of Engineering Economy, Leland Blank & Anthony Tarquin, McGraw Hill Publication (India) Private Limited
3. Engineering Economics, R.Paneerselvam, PHI publication
4. Fundamentals of Management: Essential Concepts and Applications, Pearson Education, Robbins S.P. and Decenzo David A.
5. Economics: Principles of Economics, N Gregory Mankiw, Cengage Learning
6. Modern Economic Theory, By Dr. K. K. Dewett& M. H. Navalur, S. Chand Publications

BTME505-18 HEAT TRANSFER LAB.

Course objectives:
To provide knowledge about application of conduction, convection and radiation heat transfer concepts to different practical applications

Course Outcomes:
After undergoing this course, students shall be able to:
1. Design and fabricate the experimental setups related to heat transfer phenomena.
2. Measure and analyse different heat transfer parameters.
3. Apply finite difference methods to solve simple heat transfer problems.

A. Two to three students in a group are required to do one or two practicals in the form of Lab. Project the topic/s related to the subject matter of Heat Transfer and in consultation with teacher. The comple theoretical and experimental analysis of the concerned topic is required to be performed (including desi and fabrication of new experimental set up; if required; or modifications/retrofitting in the existi experimental set ups).
B. Each student is required to use Finite Difference Method for analysis of steady state one dimension and two dimensional conduction problems (Minimum two problems one may be from the Lab. Proje such as conduction through plane/cylindrical/spherical wall with or without internal heat generation; he transfer through fins; bodies with irregular boundaries subjected to different boundary conditions.
Minimum twelve experiments from the following:
1. Composite Slab Apparatus – Overall heat transfer co-efficient.
2. Heat transfer through lagged pipe.
3. Heat Transfer through a Concentric Sphere
4. Thermal Conductivity of given metal rod.
5. Heat transfer in pin-fin
6. Experiment on Transient Heat Conduction
7. Heat transfer in forced convection apparatus.
8. Heat transfer in natural convection
9. Parallel and counter flow heat exchanger.
10. Emissivity apparatus.
11. Stefan Boltzman Apparatus.
12. Critical Heat flux apparatus.
13. Study of heat pipe and its demonstration.
14. Film and Drop wise condensation apparatus

BTME506-18 MANUFACTURING PROCESSES LAB

Course Outcomes:

After studying this course, students shall be able to:

1. Determine/calculate the clay content, moisture content, hardness, permeability and grain fineness number of moulding sand sample.
2. Use oxy-acetylene gas welding, manual arc welding, MIG, TIG and spot-welding processes to make various joints.
3. Use machine tools such as lathe, shaper and milling machine for machining/cutting various profiles on work pieces.
4. Learn about the constructional features and working of grinding machines, hydraulic press, draw bench, rolling mills, drawing and extrusion equipment.

Casting

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

Welding

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

Machining and Forming

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

Note: At least one industrial visit must be arranged for the students for the live demonstration of Casting, Welding, Forming, machining (Conventional and non-conventional) processes.

BTME507-18 NUMERICAL METHOD LAB

Course Objectives

This course provides understanding of implementations of basic numerical methods for solving differe problems *viz.* nonlinear equations, system of equations, numerical integration and ordinary differenti equations etc. The basic objective of this course is to develop capability of programming of numeric methods in the students so that they can develop and implement their own computer programs of t methods for solving different problems arising in science, engineering and technology etc.

Course Outcomes: After completion of this course, the students will be able to:

- Understand different implementation modes of numerical methods.
- Use the numerical methods with the understanding of limitations of these methods for solving problems.
- Develop and implement their own computer programs.
- Solve problems more accurately and efficiently in low computational time.
- Handle the problems conveniently which are difficult to deal with manually.

.List of experiments:

1. Make a program of bisection method for solving algebraic/transcendental equations and impleme it on some problems.
2. Develop a program of Newton-Raphson's method for solving algebraic/transcendental equations and implement it on some problems.
3. Develop and implement a program of Method of False Position for solvi algebraic/transcendental equations.
4. Develop and implement a program of Gauss-elimination method for solving a system of linear equations.
5. Develop and implement a program of trapezoidal rule to approximate a definite integral.
6. Develop and implement a program of Simpson's rule to approximate a definite integral.
7. Develop and implement a program of Euler's method for solving initial value problems of ordina differential equations.
8. Develop and implement a program of fourth order Runge-Kutta method for solving initial value problems of ordinary differential equations.
9. Develop and implement a program of two-step Adams-Bashforth method for solving initial valu problems of ordinary differential equations.
10. Develop and implement a program of two-step Adams-Moulton method for solving initial value problems of ordinary differential equations.

Note. Use any programming language/computer algebra system to develop and implement the following programs

BTME601-18 REFREGERATION AND AIR CONDITIONING

Course objectives:

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

Course Outcomes:

After undergoing this course, the student will:

12. Illustrate the fundamental principles and applications of refrigeration and air conditioning system
13. Obtain cooling capacity and coefficient of performance by conducting test on refrigeration systems.
14. Calculate the energy requirements of cooling and heat equipment for air conditioning applications.
15. Explain the properties, applications and environmental issues of different refrigerants.
16. Demonstrate an ability to analysis psychrometric processes and cycles of air conditioning systems.

Detailed Contents:

1. Basic Concepts

Classification of refrigeration systems, Refrigeration effect, cooling capacity, heating effect, heating capacity; Units of refrigeration; Coefficient of performance and Energy Performance Ratio; Single Phase Reversed Carnot cycle and its limitations; Two Phase Reversed Carnot cycle and its limitations. (4)

2. Vapour Compression Refrigeration Cycles

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

3, **Refrigerants**

Classification and nomenclature of refrigerants; Desirable thermodynamic, chemical and physical properties of refrigerants; comparative study of commonly used refrigerants and their fields of application; Azeotropes; Zeotropes; Effect of moisture and oil miscibility; Antifreeze solution; Leak detection and charging of refrigerants; Environmental aspects of conventional refrigerants; Eco-friendly refrigerants and action plan to reduce ecological hazards.

4. **Vapour Compression Refrigeration System Components**

Classifications and working of Compressors, Condensers, Expansion devices and Evaporators. Performance characteristics of the condensing unit, Performance characteristics of the compressor-capillary tube. (6)

5. Vapour Absorption Refrigeration Cycle

Principle of vapour absorption refrigeration; basic components of the vapour absorption refrigeration system; Desirable properties of absorption system refrigerant and absorbent; Aqua - ammonia vapour absorption refrigeration system; Lithium Bromide - water absorption system; Electrolux refrigeration system; comparison between vapour absorption and compression systems (no mathematical analysis). (4)

6. Psychrometry

Dry Air; Moist Air; Basic laws obeyed by Dry Air and Moist Air; Psychometric properties of air: Dry

bulb, wet bulb and dew point temperatures, Relative and specific humidity, degree of saturation adiabat saturation temperature, enthalpy of air and water vapours; Psychometric chart and its use; Numeric problems. Human requirement of comforts; effective temperature and comfort charts; Industrial ar comfort air conditioning. (5)

7. Psychometric Processes

Basic psychometric processes; Adiabatic mixing of two air streams Sensible heating; Sensible coolin cooling with dehumidification; cooling with humidification; Heating with dehumidification; Heating wi humidification; By-pass factor; Contact factor; Sensible heat factor; Room sensible heat factor; Gra sensible heat factor. (5)

8. Air conditioning Load Calculations

Sources of heat load; sensible and latent heat load; Cooling and heating load estimation; Apparatus de point temperature; Rate and state of supply air for air conditioning of different types of premises. (4)

Text/Reference Books:

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

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BTME602-18 MECHANICAL MEASURMENT AND METROLOGY

Course objectives:

1. To provide a knowledge about measurement systems and their components
2. To learn about various sensors and transducers used for measurement of mechanical quantities
3. To learn about usage of various measuring instruments
4. To learn metrology of screw, gear and surface texture

Course outcomes:

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

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

Detailed Contents:

MECHANICAL MEASUREMENT SYSTEMS: (04)

Need of mechanical measurement, basic and auxiliary functional elements of a measurement system Basic definitions: Hysteresis, Sensitivity, Linearity, Resolution, Threshold, Drift, Zero stability, loading effect and system response. Dead Time and dead zone, Measurement methods, Generalized Measurement system, Static performance characteristics, Errors and their classification.

SENSORS AND TRANSDUCERS: (05)

Introduction to sensors and transducers, types of sensors, review of electro-mechanical sensors and transducers - variable resistance, inductance and capacitive pickups, photo cells and piezoelectric transducers, Introduction to signal processing and conditioning.

LINEAR AND ANGULAR MEASUREMENTS: (04)

Vernier calliper, Micrometer, Interval measurements: Slip gauges, Checking of slip gauges for surface quality, Optical flat, Limit gauges.

MEASUREMENT OF FORCE, TORQUE AND STRAIN: (06)

Load cells, cantilever beams, proving rings, differential transformers.

Torsion bar dynamometer, Servo controlled dynamometer, Absorption dynamometers. Power Measurements.

Mechanical strain gauges, Electrical strain gauges, strain gauge material, gauge factors, theory of strain gauges, bridge arrangement, temperature compensation.

DISPLACEMENT, VELOCITY/SPEED AND ACCELERATION MEASUREMENT: (05)

Working principal of Resistive Potentiometer, Linear variable differential transducers (LVDT), Electro- Magnetic Transducers, Mechanical, Electrical and Photoelectric Tachometers, Piezoelectric Accelerometer, Seismic Accelerometer,

TEMPERATURE MEASUREMENT: (05)

Thermocouples, Resistance Temperature Detectors, Thermistor, Liquid in glass Thermometers, Pressure Thermometers, Pyrometer, Bimetallic strip. Calibration of temperature measuring devices.

METROLOGY: (02)

Basics of Metrology, Line end and wavelength standards, Need for Inspection, Accuracy and Precision, Objectives, Standards of measurements.

METROLOGY OF GEARS AND SCREW THREADS: (06)

Sources of errors in manufacturing of gears, Measurement of tooth thickness: Gear tooth Vernier, Constant chord method, Addendum comparator method and Base tangent method, Measurement of tooth profile: Tool maker's microscope or projector, Involute tester, Measurement of pitch, Measurement of run out, Lead and Backlash checking. Measurement of concentricity, Alignment of gears.

Errors in threads, screw thread gauges, measurement of element of the external and internal threads, thread calliper gauges.

METROLOGY OF SURFACE FINISH: (06)

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

COMPARATORS: (04)

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

MISCELLANEOUS METROLOGY: (04)

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

Suggested Books:

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

BTME603-18 AUTOMOBILE ENGINEERING

Course objectives:

- To understand the construction and working principle of various parts of an automobile.
- To have the practice for assembling and dismantling of engine parts and transmission system

Course Outcomes:

After undergoing this course the student will be able to:

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

Detailed Contents:

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

2. Power Unit: Power requirements - motion resistance and power loss, tractive effort and vehicle performance curves; selection of power unit and engine performance characteristics; pollution due to vehicle emission and exhaust emission control system., turbo chargers (WGT, VGT), engine emission control by 3-way catalytic converter system, Emission norms (Euro & BS).

3. Fuel Supply System: Air cleaner and fuel pumps; Air fuel requirements and carburation; constructional details of fuel injection systems (MPFI) used in Indian make vehicles. Diesel fuel system (IDI, DI & CRDI) - cleaning, injection pump, injector and nozzles. Introduction to Gasoline Direct Injection and duel fuel supply systems.

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

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

6. Transmission system: Basic requirements and components of transmission systems; constructional features of automobile clutch, gear boxes & types, differential, front and rear axles; overdrives, propeller shaft, universal joint and torque tube drive; Rear wheel vs front wheel drive, principle of automatic transmission. Types of automatic transmissions (Torque convertor AT, AMT, CVT, DCT/DSG). Traction control system.

7. Steering System: Requirement and steering geometry; castor action, camber and king pin angle, toe-in of front wheels, steering linkages and steering gears; wheel balancing & alignment; power steering (electrical and hydraulic).

8. Braking System: General braking requirements; Weight transfer during braking and stopping distances; Mechanical, hydraulic, vacuum power and servo brakes; Adaptive cruise control and braking system

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

10. Vehicle safety systems: Active and passive safety systems in an automobile. Air bags, collapsible steering system, seat belts, side impact rods, crumple zones etc. ABS & EBD, ESP, diver alert system.

11. Alternative Energy Sources : Concept and types of electric & Hybrid Vehicles . Fuel cell technology, Use of Natural Gas, Liquefied Petroleum Gas, Bio-diesel, Bio-ethanol, Gasohol and Hydrogen in Automobiles- Engine modifications required –Performance,

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12. Maintenance: Preventive maintenance, trouble shooting and rectification in different systems; engine turning and servicing

Text/Reference Books:

10. W.H Crouse, Automotive mechanics, McGraw Hill

11. J. Heitner, Automotive Mechanics, East West Press

12. Kirpal Singh, Automobile Engineering Vol. I and II, Standard Publishers

13. J. Webster, Auto Mechanics, Glencoe Publishing Co.

14. P.S Gill, Automobile Engineering, S.K Kataria

BTME604-18 INTRODUCTION TO INDUSTRIAL MANAGEMENT

Course objectives:

- To help the students gain understanding of the functions and responsibilities of industrial managements.
- To enable them to analyze and understand the environment of the organization.
- To help the students to develop cognizance of the importance of management principles.
- To provide them tools and techniques to be used in the performance of the managerial job.

Course Outcomes:

- Understand the complexities associated with management in the organizations and integrate the learning in handling these complexities.
- Demonstrate the roles, skills and functions of management.
- Understand the concepts related to industrial management.

Detailed Contents:

Unit-I: Concept of industrial engineering, Roles of industrial engineer, Tools of management science, Introduction to quality, Excellence in manufacturing, Excellence in service, factors of excellence, relevance of total quality management.
Unit-II: Concept of production, Production system, Input output model, definition of quality, Total quality control and Total Quality Management, salient features of total quality control and total quality management, benefits of total quality management.
Unit-III: Introduction to product design, Effect of design on cost, Requirements of a good product design, Factors affect product design, Product life cycle, Need and concept of product planning, Concept of product development. Introduction of industrial cost, Elements of cost, Breakeven analysis.
Unit-IV: Materials management, Purchasing, Objectives of purchasing, Activities, duties and functions of purchasing department, Purchase organizations, Buying techniques, Purchasing procedure.
Unit-V: Concept of plant maintenance, Objectives and importance of plant maintenance, Duties, functions and responsibilities of plant maintenance department, Organization of maintenance, Scheduled, preventive and predictive maintenance.
Unit-VI: Inventory, Inventory control, Objectives of inventory control, ABC analysis, Just-in-time (JIT), Definition: Elements, benefits, equipment layout for JIT system, Waste elimination, workers involvement through JIT: JIT cause and effect chain, JIT implementation.
Unit-VII: Benchmarking: Meaning of benchmarking and its concept, Definition of benchmarking, Benefits of bench marking, process and types of benchmarking.

Unit-VIII: Customer: Types of customers, Customer satisfaction, Role of marketing, Data collection, Customer complaints, Redressal mechanism.

Text Books:

1. Industrial Engineering and Management/ O. P. Khanna/ Dhanpat Rai and Sons
2. General and Industrial Management/ H Fayol/ Pitman
3. Industrial Management/ I. K. Chopde and A. M. Sheikh/ S. Chand
4. A Text Book of Industrial Management/ A. P. Verma and N. Mohan/ Katson
5. Total Quality Management/ Jeol E. Ross/ Taylor and Francis Limited.

BTME605-18 REFREGERATION AND AIR CONDIITONING LAB

Course Outcomes:

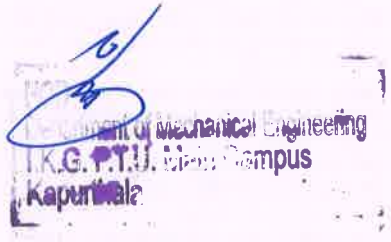
1. Conduct and analyze the experimental data of performance of vapour compression refrigerati system in domestic refrigerator and water cooler.
2. Conduct and analyze the experimental data of performance of Electrolux Refrigerator.
3. Conduct the performance of window type room air conditioner and system.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

Course Objectives:

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

List of Experiments

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



BTME606-18 MECHANICAL MEASUREMENT AND METROLOGY LAB

The student will be able to:

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

List of experiments:

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

BTME607-18 AUTOMOBILE ENGINEERING LAB

The student will be able to:

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

List of Experiments

1. Valve refacing and valve seat grinding and checking for leakage of valves
2. Trouble shooting in cooling system of an automotive vehicle
3. Trouble shooting in the ignition system, setting of contact breaker points and spark plug gap
4. Demonstration of steering system and measurement of steering geometry angles and their impact vehicle performance.
5. Trouble shooting in braking system with specific reference to master cylinder, brake shoes, overhauli of system and the adjusting of the system and its testing.
6. Fault diagnosis in transmission system including clutches, gear box assembly and differential.
7. Replacing of ring and studying the method of replacing piston after repair.
8. Dismantling and assembling of diesel and petrol engine.
9. Study of cut section model of Petrol and diesel engine.

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BTME609-18 INTERNAL COMBUSION ENGINES

Course Outcomes:
Students who have done this course will have

1. Knowledge about the basics of IC engines
2. Ability to evaluate operational characteristics of IC Engines
3. Ability to ascertain the effects of fuel/supply systems on emission from an engine.
4. Ability to test engine performance

Detailed Contents:

1. Introduction to IC Engines:
Definition of engine; Heat Engine, Historical Development of IC Engines, Classification & Nomenclature, Application of IC Engines, Air Standard Cycle, Carnot Cycle, Sterling Cycle, Ericson Cycle, Otto Cycle, Diesel cycle, Dual Cycle, Thermodynamics Analysis of these cycles.

2. Actual Working of I.C. Engine:
Working of 4 stroke petrol & diesel engines and their valve timing diagram, working of 2-stroke petrol & diesel engines & their valve timing diagrams, comparison of two stroke & four stroke engines, Actual working of 2 & 4 stroke gas engines and their valve diagram.

3. Fuel Air Cycles and their analysis:
Introduction to fuel air cycles and their significance, composition of cylinder gases, variable specific heats, Dissociation, effect of no. of moles, comparison of air standards & fuel air cycles, effect of operating variable like compression ratio, fuel air ratio, actual cycles and their analysis; Difference between Actual and Fuel-Air Cycle, Actual and Fuel-Air Cycles for S.I. and C.I. Engines.

4. Fuel Supply System:
Fuel Supply System and fuel pumps, properties of air fuel mixture, a sample carburetor an its working, approximate analysis of simple carburetor, Actual air fuel ratio of single jet carburetor, Exact analysis of single jet carburetor, ideal requirements from a carburetor, limitations of single jet carburetor, different devices used to meet the requirements of an ideal carburetor. modern carburetors.

5. Fuel Injection Systems:
Requirement of an Injection system, Classification of Mechanical injection systems, Fuel Feed pump, injection pump, injection pump Governor, mechanical governor, Fuel Injector, Nozzle, Injection of S.I. Engines. Electronic fuel injection system, MPFI system, Electronic Control system, injection timings and modern injection systems.

6. Combustion in S.I. and C.I Engines:
Introduction, Stages of Combination in S.I. Engine, Flame font propagation, factor influencing the flame speed, ignition lag and factors affecting the lag, Abnormal combustion and knocking, control and measurement of knock, effect of engine variables on knocking, rating of S.I. Engine fuels and anti-knock agents, combustion chambers of S.I. Engines. Stages of Combination in C.I. Engine, factors affecting delay period, phenomenon of knock in C.I. Engines, comparison of Knocking in S.I and C.I. engines, combustion chambers for C.I. Engines.

7. Supercharging:
Introduction, purpose of supercharging, type of superchargers, analysis of superchargers, performance of superchargers, Arrangement of Supercharger and its installation, Turbo charged engines, supercharging of S.I. & C.I. Engines. Limitations of supercharging.

8. Engine Emissions and Control
Introduction, Ambient pollution due to engines, emission norms, engine emissions, hydrocarbons ar hydrocarbon emissions, CO emission, Oxides of Nitrogen, particulates, other emissions. Emission contr methods, catalytic convertors, particulate traps. Methods to control/reduce harmful emissions.

9. Measurement and Testing:
Measurement of friction horse power, brake horse power, indicated horse power, measurement of spee air consumption, fuel consumption, heat carried by cooling water, heat carried by the exhaust gases, he balance sheet, governing of I.C. Engines, performance characteristics of I.C. Engines: Performan parameters, performance of S.I. Engines, performance of C.I. Engine, Engine performance maps.

Text/Reference Books:

1. V. Ganesan, Internal Combustion Engines, Prentice Hall.
2. V. M. Damundwar, A Course in Internal Combustion Engines, Dhanpat Rai.
3. John B. Heywood, Internal combustion engine fundamentals McGraw-Hill,
4. Colin R. Ferguson, Allan Thomson, Kirkpatrick Internal combustion engines: applied thermo sciences, John Wiley & Sons
5. Richard Stone, Introduction to Internal Combustion Engines Society of Automotive Engineers.
6. Mathur and Sharma, A course in Internal Combustion Engines, Dhanpat Rai.

BTME610-18 Mechatronics System

After successfully completing this course the students will be able to

CO1: Design mux, demux, flip-flops, and shift registers.

CO2: Describe the block diagram, registers, ALU, bus systems, timing & control signals, instruction cycles, and interrupts of 8085 microprocessors.

CO3: Apply the concept of 8085 microprocessor instruction sets and addressing modes in writing assembly language program for a given problem.

CO4: Describe the interfacing of memory, 8255 PPI, ADC, DAC, 7-segment LED system, stepper motor, 8251 and 8253 ICs with 8085 microprocessor

Introduction: Definition of Mechanical Systems, Philosophy and approach; Systems and Design: Mechatronic approach, Integrated Product Design, Modeling, Analysis and Simulation, Man-Machine Interface;

Sensors and transducers: classification, Development in Transducer technology, Optoelectronics-Shaft encoders, CD Sensors, Vision System, etc.;

Drives and Actuators: Hydraulic and Pneumatic drives, Electrical Actuators such as servo motor and Stepper motor, Drive circuits, open and closed loop control;

Embedded Systems: Hardware Structure, Software Design and Communication, Microprocessors and microcontrollers: Microprocessor systems, Microcontrollers, Applications, programmable logic controller, Basic PLC structure, input and output units, Programmable Logic Devices, Input/output processing, Ladder programming,

Smart materials: Shape Memory Alloy, Piezoelectric and Magneto strictive Actuators: Materials, Static and dynamic characteristics, illustrative examples for positioning, vibration isolation, etc.; Micro mechatronic systems: Microsensors,

Mechatronic systems: Mechatronic designs, Case studies.

Course Outcomes: Upon completion of this course, students will get an overview of mechatronics applications and the use of micro-sensors and microprocessors.

Text Books:

1) Mechatronics System Design, Devdas Shetty & Richard A. Kolk, PWS Publishing Company (Thomson Learning Inc.)

2) Mechatronics: A Multidisciplinary Approach, William Bolton, Pearson Education

3) A Textbook of Mechatronics, R.K. Rajput, S. Chand & Company Private Limited

4) Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, William Bolton, Prentice Hall

BTME611-18 MICROPROCESSOR IN AUTOMATION

Course objectives:

To introduce the basic concepts of Digital circuits, Microprocessor system and digital controller

Course outcomes:

Students who have done this course will have a good idea of the use of microprocessors for automation

Detailed Contents:

Unit I: Number Systems, codes: BCD, Excess 3, digital electronics: Logic Gates, combinational circui design: Mux, Demux, Sequential logic circuits design: Flip-flops, Shift registers.

Unit II: Introduction to 8085 Functional Block Diagram, Registers, ALU, Bus systems, Timing a control signals. Machine cycles, instruction cycle and timing states, instruction timing diagrams, Memo interfacing.

Unit III: Assembly Language Programming: Addressing modes, Instruction set, simple programs in 808 Concept of Interrupt, Need for Interrupts, Programmable interrupt controller; Interfacing peripheral Programmable peripheral interface (8255).

Unit IV: Interfacing Analog to Digital Converter & Digital to Analog converter, Multiplexed sev segments LED display systems, Stepper Motor Control, Data Communication: Serial Data communicati (8251), Programmable Timers (8253)

Text/Reference Books:

1. Digital Electronics: An Introduction to Theory and Practice, William H. Gothmann, PHI Learning Private Limited
2. Digital Computer Electronics: An Introduction to Microcomputers, Albert Paul Malvino, Tata McGraw-Hill Publishing Company Ltd.
3. Microprocessor Architecture, Programming, and Applications with the 8085, Ramesh Gaonkar, PENRAM International Publishers.
4. Digital Control Systems, Benjamin C. Kuo, Oxford University Press (2/e, Indian Edition, 2007).
5. Microcomputer Experimentation with the Intel SDK-85, Lance A. Leventhal, Prentice Hall

BTME612-18 COMPOSITE MATERIALS

Course outcomes:
Students who have studied this course will have

1. Understanding about the concept, need and applications of composite materials.
2. Ability to suggest/select optimum combination of Matrix/Reinforcement for various engineering applications.
3. Ability to analyze the effects of influencing factors on the strength of composite materials.

Detailed Contents:
1 Introduction

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

2 Reinforcements

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

3 Matrix Materials

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

4 Interfaces

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

5 Polymer Matrix Composites

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

Recycling of PMCs.

6 Metal Matrix Composites

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

7 Ceramic Matrix Composites

Processing of CMCs, Cold Pressing and Sintering, Hot Pressing, Reaction Bonding Processes, Infiltratic Directed Oxidation or the Lanxide™ Process, In Situ Chemical Reaction Techniques, Sol–Gel, Polym Infiltration and Pyrolysis, Electrophoretic Deposition, Self-Propagating High-Temperature Synthes Interface in CMCs, Properties of CMCs, Toughness of CMCs, Crack Deflection at the Interface in a CM Thermal Shock Resistance, Applications of CMCs, Cutting Tool Inserts, Ceramic Composite Filters, Oth Applications of CMCs

8 Carbon Fiber/Carbon Matrix Composites

Processing of Carbon/Carbon Composites, High Pressure Processing, Oxidation Protection Carbon/Carbon Composites, Properties of Carbon/Carbon Composites, Thermal Properties, Friction Properties of the Composites, Ablative Properties, Applications of Carbon/Carbon Composit Carbon/Carbon Composite Brakes, Other Applications of Carbon/Carbon Composites, Carbon/SiC Bra Disks

9 Multifilamentary Superconducting Composites

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

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

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

BTME613-18 COMPUTER AIDED DESIGN

Course outcomes:

The students will be able to

1. Create the different wireframe primitives using parametric representations.
2. Create surface primitives using parametric modeling.
3. Create the different solid primitives using the different representation schemes.
4. Apply geometric transformations on the created wireframe, surface and solid models.

Detailed Contents:

Unit 1: Introduction: Historical Development, Geometric Modeling, Explicit and Implicit Equations, Intrinsic Equations, Parametric Equations, Coordinate Systems.

Unit 2: Curve Design: Fundamental of Curve Design, Parametric Space of a Curve, Blending Functions, Reparametrization, Space Curves, Straight lines, Spline Curves, Bezier Curves, B-Spline Curve, Rational Polynomials, NURBS.

Unit 3: Surface Design: Fundamental of Surface Design, Parametric Space of a Surface, Reparametrization of a Surface patch, Sixteen Point form, Four Curve Form, Plane surface, Cylindrical and Ruled Surfaces, Surface of Revolution, Bezier Surface, B-Spline Surface.

Unit 4: Solid Design: Fundamental of Solid Design, Parametric Space of a Solids, Continuity and Composite Solids, Surfaces and Curves in a Solid.

Unit 5: Solid Modeling: Topology and Geometry, Set Theory, Boolean Operators, Set-membership Classification, Euler operators, Graph Based Models, Boolean Models, Instances and Parameterized Shapes, Cell Decomposition and Spatial Occupancy Enumeration, Sweep Representation, Constructive Solid Geometry, Boundary Representation.

Unit 6: Transformations: Translation, Rotation, Scaling, Symmetry and Reflection, Homogeneous Transformations, Orthographic Projections, Axonometric Projections, Oblique Projections, Perspective Transformation.

Unit 7: Assembly Design: Assembly-Modeling, Analytical Properties, Relational Properties and Intersections, Data Transfer Formats.

Recommended Books:

1. Zeid, I., CAD/CAM, McGraw Hill (2008).
2. Rogers, D. F. and Adams, J. A., Mathematical Elements for Computer Graphics, McGraw Hill (1989).
3. Rogers, D. F., Procedural Elements for Computer Graphics, McGraw Hill (2008).
4. Rooney, J. and Steadman, P., Principles of Computer Aided Design, prentice Hall (1988).
5. Mallineuse, G., Computational Concepts and Methods, Kogan Page Ltd. (1986).]
6. Radhakrishnan, P. and Kothandaraman, C. P., Computer Graphics & Design, Dhanpat Rai Publication (2005).

BTME614-18 PRODUCT DESIGN AND DEVELOPMENT

The student will be able to:

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

Introduction to Product Design: Design by Evolution and Innovation, Essential factors of produ design, Production consumption cycle, Flow and value addition in Production consumption cycle, Th Morphology of Design, Primary design phases and flowcharting, Role of Allowances, process capabili and tolerances in detailed design and assembly

Product Design and Industry: Product Strategies, Time to Market, Analysis of the Produc Standardization, Simplification and specialization, Basic design considerations, Role of Aesthetics product design, Functional design practice

Design for Production: Producibility requirements in the design of machine components, Forging desig Pressed component design, Casting design for economical molding, eliminating defects and features to a handling, Design for machining ease, the role of process Engineer, Ease of location and Clamping, Son additional aspects of production design, Design of powder metallurgical parts

Economic Factors Influencing Design: Product value, Design for safety, reliability and Environment considerations, Manufacturing operations in relation to design, Economic analysis, profit an competitiveness, break even analysis,

Modern Approaches to product Design: Concurrent Design, Quality Function Deployment (QFD)

Rapid Prototyping: Principle of Rapid Prototyping, Rapid Prototyping Technologies (RPT), RPT Industrial Design.

Books Recommended

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

BTME615-18 NON-CONVENTIONAL ENERGY RESOURCES

Course outcomes:

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

1. Address smart energy and green infrastructure
2. Build models that simulate sustainable and renewable green technology systems
3. Understand the history, global, environmental and economical impacts of green technology
4. Address nonrenewable energy challenges

Unit I

An introduction to energy sources, Environmental Aspects of Power Generation. Heat Transfer from Solar Energy, Physical principles of conversion of solar radiation into heat utilization, Flat Plate Collectors (FPC), Thermal losses and efficiency of FPC, Practical considerations for flat plate collectors, Applications of FPC – Water heating and drying, Focusing Type Collectors: orientation and sun tracking systems, Types of concentrating collectors – cylindrical parabolic collector, compound parabolic collector, Thermal performance of focusing collectors.

Unit II

Solar energy storage system, Application of solar energy: solar water heating, space heating and cooling, solar photovoltaic, solar cooking, solar distillation & desalination , Solar industrial process heating, Solar power generation. Solar Green Houses, Solar thermo mechanical power, solar refrigeration & air conditioning, Solar ponds.

Unit III

Energy from Biomass: Type of biomass sources, Energy plantation, Methods for obtaining energy from biomass, Biomass conversion technologies-wet and dry processes, Biodigestion, Community/Industrial biogas plants, Factors affecting biodigestion, Design of a biogas plant, Classification, advantages and disadvantages of biogas plants, Problems related to biogas plants, Utilization of biogas. Thermal gasification of biomass, Gasifier- classification, chemistry, advantages, disadvantages and application. Alcohol fuels from biomass: overview, feedstock, methods for alcohol production, Ethanol as an alternative liquid fuel; engine performance with alcohol fuels, biodiesel from biomass.

Unit IV

Wind Energy: Basic principles of wind energy conversion: power in the wind, maximum power, forces on the blades, lift and drag, Components of wind energy conversion systems (WEC), Classification, advantages and disadvantages of WEC systems, Types of wind machines, Performance of wind machines, Design considerations, Energy storage, Application of wind energy, Environmental aspect. Tidal Energy. Components of tidal power plants, Single and double basin arrangements, Estimation of energy and power, Advantages and limitations of tidal power. Wave energy- its advantages and disadvantages, energy and power from wave energy.

Unit V

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

Text Books:

1. G D Rai, 'Non-Conventional Energy Sources', Khanna Publishers. Delhi, 2010
2. S P Sukhatme, 'Solar Energy-Principles of Thermal Collection & Storage', Tata McGraw Hill Publishing Company Ltd., New Delhi

Reference Books

1. John A Duffie & William A Beckman, 'Solar Energy Thermal processes', Wiley Interscience publication .
2. P Garg & J Prakash,' Solar Energy - Fundamentals and Applications', Wiley Interscience publication. 3. Jay Cheng, 'Biomass to Renewable Energy Processes', 1st Edition, CRC press, 2009.

BTME616-18 OPERATION RESEARCH

Course objectives:

The course is designed to understand the mathematical, engineering and modeling skills that may be usef for designing and solving complex industrial/social/economic problems using various optimization mode like deterministic and probabilistic models, simulations, queuing theory, inventory model, replacemen models and network models, etc.

Course outcomes:

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

Detailed Contents:

1. Introduction

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

2. Deterministic Models

Formulation of deterministic linear mathematical models: Graphical and simplex techniques for soluti of linear programming problems, Big M method and two phase method, Introduction to duality theory a sensitivity analysis: transportation, assignment and sequencing models; Introduction to goal programmin Solution techniques of linear goal programming problems. (6)

3. Probabilistic Models

Decision making under uncertainty: Maximum and minimum models; Introduction to decision tree. Gar theory: Solution of simple two person zero-sum games: Examples of simple competitive situation. (4)

4. Simulation

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

5. Dynamic Programming

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

6. Queuing Theory

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

7. Replacement Models

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

8. Inventory Models

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

9. Network Models

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

Text/Reference Books:

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

BTME617-18 MAINTENACE & RELIABILITY

Course objectives:

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

Course outcomes:

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

Detailed Contents:

1. Introduction:
Objective and characteristics of maintenance function, Organization of the maintenance system, Operati practices in maintenance, Maintenance record keeping.

2. Cost Aspect of Maintenance:
Costs of machine breakdown, estimation of life cycle costs, Application of work measurement in maintenance, Manpower planning and training, Incentive payments for maintenance.

3. Planning of Maintenance Activities:
Evaluation of alternative maintenance policies breakdown, preventive and predictive maintenance, fa diagnosis and condition monitoring techniques, simulation of alternative practices, Development preventive maintenance schedule, House keeping practices, total productive maintenance.

4. Maintenance Engineering:
Maintenance requirements of mechanical, electrical, process and service equipment, Safety aspect maintenance, Aspect of lubrication; chemical control of corrosion, Computerized maintenance informati systems.

5. Reliability:
Concept and definition, configuration of failure data, various terms used in failure data analysis in mathematical forms, component and system failures, uses of reliability concepts in design a maintenance of different system.

6. Reliability and Availability of Engineering systems:
Quantitative estimation of reliability of parts, Reliability of parallel and series elements, Accuracy a confidence of reliability estimation, Statistical estimation of reliability indices, Machine failure patte Breakdown time distribution.

7. Reliability improvement:
Reliability in design, reliability in engineering, systems, systems with spares, reliability simulati redundant and stand by systems, confidence levels, component improvement element, unit and stanc redundancy optimization and reliability-cost trade off.

8. Fault Tree Analysis:

Introduction and importance, fault tree construction, reliability calculations from fault tree, tie set and cut set methods, event tree and numerical problems.

Suggested Books:

1. Lindley R. Higgins, Maintenance Engineering Handbook, McGraw Hill.
2. R.H. Clifton, Principles of Planned Maintenance, Edward Arnold.
3. A Kelly, Maintenance Planning control, McGraw Hill.
4. L.S Srinath, Reliability Engineering, East West Press.
5. S.K. Sinha, Reliability Engineering, John Wiley.

MECHANICAL VIBRATIONS
(BTME701-18)

Course Outcomes

After completion of this course, the students will be able to
CO1: Formulate mathematical models of problems in vibrations using Newton's second law or ener principles
CO2: Understand the need and measurement of vibration in mechanical systems
CO3: Calculate principal modes of vibration
CO4: Explore the suitable methods of vibration reduction and absorption
CO5: Ability to determine vibratory responses of SDOF and MDOF systems
CO6: Create the mathematical model of a vibratory system to determine its response

UNIT - I Introduction, Classification of Vibration Systems, Harmonic motion, Vector representation harmonic motion, Natural frequency & response, Effects of vibration, superposition of simple harmor motions, beats, Fourier analysis-analytical and numerical methods. Single Degree Freedom Syste Equation of motion, Newton's method, D'Alembert's principle, Energy method etc., Free vibratic Natural frequency, Equivalent systems, Displacement, Velocity and acceleration, Response to an init disturbance, Torsional vibrations, Damped vibrations, Vibrations of systems with viscous dampir Logarithmic decrement, Energy dissipation in viscous damping.
UNIT - II Single Degree Freedom: Forced Vibration Forced vibration, Harmonic excitation with visco damping, steady state vibrations, forced vibrations with rotating and reciprocating unbalance, supp excitation, Vibration isolation, Transmissibility, Vibration measuring instruments, Displacement, veloc and acceleration measuring instruments.
UNIT- III Two Degree Freedom systems Introduction, Principal modes, Double pendulum, Torsior system with damping, Coupled system, Principle of vibration absorber, Undamped dynamic vibrati absorbers, Torsional vibration absorber, Centrifugal pendulum absorbers, Vibration isolators a Dampers.
UNIT- IV Multi-degree Freedom system: Exact Analysis, Undamped free and forced vibrations of mu degree freedom systems, influence coefficients, Reciprocal theorem, Torsional vibration of multi-deg rotor system, Vibration of gear system, Principal coordinates, Continuous systems- Longitudi vibrations of bars, Torsional vibrations of circular shafts.
UNIT- V Multi Degree Freedom system: Numerical Analysis by Rayleigh's method, Dunkerely Holzer's and Stodola methods, Rayleigh-Ritz method 5 Critical speed of shafts, Whirling of uniform sh Shaft with one disc with and without damping, Multi-disc shafts, Secondary critical speed.

Books and References:

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

AUTOMATION IN MANUFACTURING
(BTME702-18)

Course Outcomes

After completion of this course, the students will be able to
CO1: Students should be able to design and implement automated systems using pneumatics.
CO2: Students should be able to provide hydraulic solutions for designing automated systems.
CO3: Students should be able to design and implement electro-pneumatic/hydraulic solutions for automated systems.
CO4: Students should be able to apply PLC programming and implement it on PLC kits.
CO5: Students should be able to devise Assembly automated systems using feeders, orienteers and escapement devices

Course Objectives: To understand the importance of automation and a thorough knowledge of its various elements such as sensors, pneumatics, hydraulics and CNC.

Introduction:
Importance of automation in the manufacturing industry. Use of mechatronics. Systems required. Rigid and Flexible automation, Computer control of Machine Tools and Machining Centers,

Design of an automated system:
Building blocks of an automated system, working principle and examples, Fabrication or selection of various components of an automated system. Specifications of various elements. Use of design data books and catalogues.

Data Acquisition:
Study of various sensors required in a typical automated system for manufacturing. Construction and principle of operation of sensors, signal conditioning and data acquisition, use of microprocessor or micro controllers. Configurations. Working.

Drives:
Electrical drives – types, selection criteria, construction and operating principle.

Automation Mechanisms:
Ball screws, linear motion bearings, cams, systems controlled by camshafts. Electronic cams, indexing mechanisms, tool magazines, and transfer systems.

Hydraulic and Pneumatic systems:
hydraulic power pack, pumps, valves, designing of hydraulic circuits, configurations, compressors, valves, distribution and conditioning.

CNC technology:
NC and NC part programming, CNC-Adaptive Control, Automated Material handling. Assembly, basic elements, interpolators and programming.

Books

1. Tonshoff, H.K. and I. Inasaki, Sensors in manufacturing,Wiley-VCH, 2001.
2. HMT Ltd. Mechatronics, Tata McGraw-Hill, New Delhi, 1988.
3. Bradley, D. A., Dawson D., Burd, N. C. and Loader A. J.,Mechatronics: Electronics in products and processes, CRC Press, Florida, USA, 2010.

4. Rothbart, H. A., CAM Design Handbook, McGraw-Hill, 2004.• Norton, R. L., Cam Design a
Manufacturing Handbook,Industrial press Inc, 2002.
5. Groover, M. P., Automation, Production Systems, and Computer-Integrated Manufacturin
Prentice Hall, 2001.
6. Parr, A. A., Hydraulics and pneumatics, Elsevier, 1999.
7. Smid, P., CNC Programming Handbook, Industrual Press,New York, USA, 2008.
8. Rao, P. N., CAD/CAM Principles and Applications, Tata McGraw Hill, New Delhi, 2010.

Fundamentals of Management for Engineers (BTME703-18)

Course Objectives: -

- To understand the Management Concepts, applications of Concepts in Practical aspects of business and development of Managerial Skills for Engineers.
- To help the students gain understanding of the functions and responsibilities of industrial managements.
- To enable them to analyze and understand the environment of the organization.
- To help the students to develop cognizance of the importance of management principles.
- To provide them tools and techniques to be used in the performance of the managerial job.

Course Outcomes: -

- The students understand the significance of Management in their Profession.
- The various Management Functions like Planning, Organizing, Staffing, Leading, aspects are learnt in this course.
- Understand the complexities associated with management in the organizations and integrate the learning in handling these complexities.
- Demonstrate the roles, skills and functions of management.

UNIT-I

Introduction to Management: Definition, Nature and Scope, Functions of Management, Managerial Roles, Levels of Management, Managerial Skills, Challenges of Management.

UNIT-II

Introduction to Operations Management, . Types of Plant Layout, Introduction to Total Quality Management (TQM), Total Quality Management Models, Benefits of TQM, Basics of Six Sigma and Lean Manufacturing.

UNIT-III

Introduction to Marketing, Functions of Marketing, Types of Marketing, Marketing vs. Selling, Marketing Mix, Product Life Cycle, Market Segmentation, Supply Chain Management (SCM).

UNIT-IV

Introduction to Work Analysis, Definition, need and scope of work analysis, Method Study: Objectives, Step-by-step procedure, Charts and diagrams for recording data, Principles of Motion economy, Therbligs, Work Measurement: Definition, Various techniques of work measurement such as Work Sampling, Stop Watch Time Study, Analytical Estimating, Predetermined Motion Time System, Need for operator rating, Methods of rating, Allowances and their types, Standard time

UNIT-V

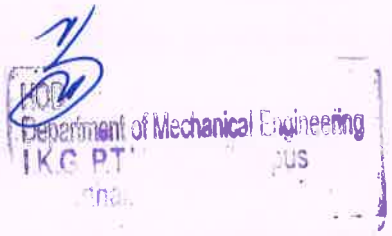
Introduction to Productivity: Definition, Reasons for low productivity, methods to improve productivity, Value Engineering: Definition, Types of values, concept, phases and applications of value engineering

UNIT-VI

Introduction to Personnel Management, aims and objectives of personnel management, Principles of good personnel policy, Recruitment and selection of employees, Education and training of employee Safety engineering.

BOOKS:

6. Industrial Engineering and Management/ O. P. Khanna/ Dhanpat Rai and Sons
7. Management Essentials/ Andrew Dubrin/ Cengage Learning
8. Fundamentals of Management/ Stephen P. Robbins/ Pearson Education
9. General and Industrial Management/ H Fayol/ Pitman
10. Industrial Management/ I. K. Chopde and A. M. Sheikh/ S. Chand
11. A Text Book of Industrial Management/ A. P. Verma and N. Mohan/ Katson



Study Scheme & Syllabus of

M. Tech. Mechanical
(Manufacturing Engineering and Automation)

Batch 2021 onwards

(For Main Campus only)

By

Department of Academics

IK Gujral Punjab Technical University

Study Scheme of M. Tech. Mechanical
(Manufacturing Engineering and Automation)

(Batch 2021 Onwards)

SEMESTER 1st		Contact Hours/Week			Maximum Marks			Credits
Subject Code	Subject Name	L	T*	P	Int.	Ext.	Total	
MTME-101	Advanced Engineering Materials	4	0	0	50	100	150	4
MTME-102	Modern Manufacturing Processes	4	0	0	50	100	150	4
MTME-103	Advanced Casting Processes	4	0	0	50	100	150	4
MTME-104	Operations Management	4	0	0	50	100	150	4
MTME-105	Metal Forming	4	0	0	50	100	150	4
	Total	20	0	0	250	500	750	20
Total Contact Hours/Week = 20								
* Tutorials involve problems solving sessions including practice on relevant software								

SEMESTER 2nd		Contact Hours/Week			Maximum Marks			Credits
Subject Code	Subject Name	L	T	P	Int.	Ext.	Total	
MTME-201	Research Methodology	3	1*	0	50	100	150	4
MTME-202	Advanced Welding Technology	4	0	0	50	100	150	4
MTME-203	Corrosion Science	4	0	0	50	100	150	4
MTME-204	Advanced Material Characterization Techniques	3	1*	0	50	100	150	4
MTME-XXX	Elective –I	4	0	0	50	100	150	4
	Total	18	2	0	250	500	750	20
Total Contact Hours/Week = 20								
* Tutorials involve problems solving sessions including practice on relevant software								

SEMESTER 3rd		Contact Hours/Week			Maximum Marks			Credits
Subject Code	Subject Name	L	T	P	Int.	Ext.	Total	
MTME-301	Industrial Automation	3	0	0	50	100	150	3
MTME-YYY	Elective-II	4	0	0	50	100	150	4
MTME-ZZZ	Elective-III	4	0	0	50	100	150	4
MTME-302	Mechatronics and IoT lab			2	30	20	50	1
MTME-303	Thesis (Dissertation Part-I)	-	-	6	50	50	100	3
MTME-304	Seminar	-	-	2	100	--	100	1
	Total	11	0	10	330	370	700	16
Total Contact Hours/Week = 16								

SEMESTER 4th		Contact Hours/Wee			Evaluation Criteria	Credits
Subject Code	Subject Name	L	T	P		
MTME-401	Thesis (Dissertation part-II	0	0	28	Satisfactory/Unsatisfactory	14
Total Contact Hours/Week = 28						

Total Credits for the Programme: 70

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List of Elective Subjects for M. Tech. Mechanical (Manufacturing Engineering and Automation)

List of Electives (Manufacturing Engineering and Automation)

1.	MTME-205	Tribology
2.	MTME-206	Industrial Robotics
3.	MTME-207	Plastics Engineering
4.	MTME-208	Rapid Prototyping
5.	MTME-209	Advanced Metal Cutting
6.	MTME-210	Computer Aided Design & Manufacturing
7.	MTME-211	Maintenance and Reliability Engineering
8.	MTME-212	Supply Chain Management
9.	MTME-213	Production Planning and Control
10.	MTME-214	Product Design and Development
11.	MTME-215	Entrepreneurship
12.	MTME-216	Work System Design and Ergonomics
13.	MTME-217	Metrology & Industrial Inspection
14.	MTME-218	Finite Element Analysis
15.	MTME-219	Low cost Automation

Note:

(A) Student can opt Elective I, II & III subjects from the entire list of electives as above.

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MTME-101 ADVANCED ENGINEERING MATERIALS

L	T	P
4	0	0

Classification and Selection of Materials

Classifications of materials, properties required in Engineering materials, selection of materials, Requirements/ needs of advance materials.

Composite Materials

Fiber reinforced, laminated and dispersed materials with metallic matrix of aluminium, copper and Titanium alloys and with non-metallic matrix of unsaturated polyesters and epoxy resins. Development, Important properties and applications of these materials.

Ceramics and Glasses - Bio-ceramics

Nearly inert ceramics, bio-reactive glasses and glass ceramics, porous ceramics; Calcium phosphate ceramics: grafts, coatings Physico-chemical surface modification of materials used in medicine.

Low & High Temperature Materials

Properties required for low temperature applications, Materials available for low temperature applications, Requirements of materials for high temperature applications, Materials available for high temperature applications, Applications of low and high temperature materials.

Smart Materials

Shape Memory Alloys, Varistors and Intelligent materials for bio-medical applications, Polymers and Plastics from industry. Development, important properties and applications of these materials.

Nanomaterials

Definition, Types of nanomaterials including carbon nanotubes and nanocomposites, Physical and mechanical properties, Applications of nanomaterials.

Books Recommended:

1. Engineering Material Technology by James A. Jacobs & Thomas F. Kilduff. Prentice Hall.
2. Materials Science and Engineering by WD. Callister Jr., Wiley India Pvt. Ltd., 2010
3. Engineering Design: A Materials and Processing Approach by G.E. Dieter, McGraw Hill, 1991.
4. Materials Selection in Mechanical Design by M.F. Ashby, Pergamon Press, 1992.
5. Introduction to Engineering Materials & Manufacturing Processes by NIIT, Prentice Hall of India.
6. Engineering Materials Properties and Selection by Kenneth G. Budinski, Prentice Hall of India.
7. Selection of Engineering Materials by Gladius Lewis, Prentice-Hall, New Jersey, US.

MTME-102 MODERN MANUFACTURING PROCESSES.

L	T	P
4	0	0

Introduction
Introduction to different advanced processes, importance and applications of advanced manufacturing processes. Overview: non-conventional machining Processes

Mechanical Machining Processes
Abrasive jet machining, Ultrasonic machining, Abrasive flow finishing, Magnetic abrasive finishing, Water jet cutting, Abrasive water jet machining process: working principle, theory of material removal, process variables and parametric analysis, process performance, determination of material removal rate and surface finish.

Thermodynamic Machining Processes
Electrical discharge machining (EDM), Electrical discharge grinding (EDG), WEDM, LBM, PAM, EBM: working principle, theory of material removal, process variables and parametric analysis, process performance, determination of material removal rate and surface finish.

Electrochemical and Chemical Machining Processes
Chemical machining (ChM), ECM, ECG, electrochemical stream drilling (ESD), electrochemical deburring (ECDe), shaped tube electrolytic machining (STEM): working principle, theory of material removal, process variables and parametric analysis, process performance, determination of material removal rate and surface finish

Powder Metallurgy
Important characteristics and methods of producing powders, Different techniques to form the miniature product from metal power, Extruding, Isostatic molding, Fibre metal process, Sintering Hot pressing.

Special Manufacturing Processes
Physical vapor deposition, chemical vapor deposition, thermal metal spraying and Additive manufacturing such as 3-D printing.

Books Recommended:

1. Advanced Manufacturing Processes by G.F. Benidict, Marcel Deker publisher.
2. Non-conventional Machining Processes by P.K. Mishra, Narosa Publication.
3. Manufacturing Processes by B.H. Amsteal, Philip F. Ostwald & Myron L. Bengeman, John Wiley & Sons, eighth edition
4. Manufacturing Analysis by N. Cook.
5. Modern Machining Processes by P.C. Pandey and H.S. Shan, Tata McGraw-Hill Education
6. Advanced Machining Processes by V.K.Jain

MTME – 103 ADVANCED CASTING PROCESSES

L	T	P
4	0	0

Introduction

Ferrous and non-ferrous materials and their properties, Pattern materials, types and allowances, Characteristics, Ingredients and additives of moulding sand, core sands, Structure of silica and different types of clays, bonding mechanism of silica-water-clay system, Swelling of clays, sintering adhesion and colloidal clay, silica grain shape and size distribution, standard permeability A.F.S. clay, Special sandadditives

Solidification of Metals
Nucleation and growth in metals and alloys, Free energy concept, Critical radius of nucleus, Segregation, Progressive and directional solidification, Constitutional super cooling, Columnar equiacquiesced and dendritic structures, Freezing of alloys, Centreline feeding resistance, Rate and time of solidification, mould constant, Fluidity of metals, Volumes redistribution, Solidification simulation, Analysis of the process.

Gate and Riser Design
Various elements of gating system, gating-system design for ferrous and non-ferrous materials, Top, bottom and inside gating, Different methods for riser design, Riser design shape, size and placement, Effect of appendages on risering, Effective feeding distances for simple and complex shapes, Use of chills, Aspiration of gases, Directional solidification stresses in castings, Metal mould reactions, Expansion scale and metal penetration, Analysis of the process

Advanced Casting Processes
Investment casting, Shell mould casting, Full mould casting, Vacuum casting, Die casting, Permanent mould casting, Continuous casting, Centrifugal casting, Squeeze casting, Slush casting

Casting Defects, Heat-Treatment of Castings and Moulding Sand Testing
Casting defects, causes and remedies; Heat treatment of steel, iron and stainless-steel castings; Moulding sand testing and control, Repair and salvage of castings, Quality control in foundries.

Books Recommended:

1. Flimm, Fundamentals of Metals Casting, Addison Wesley
2. P. N. Rao, Manufacturing Technology - Foundry, Forming and Welding, Tata McGraw Hill
3. Heine Loper and Resenthal, Principles of Metal Casting, McGraw Hill
4. Salman & Simans, Foundry Practice, Issac Pitman
5. Richard W. Heine, Principles of Metal Casting Processes, McGraw Hill
6. P. L. Jain, Principles of Foundry Technology, Tata McGraw Hill
7. Metals Handbook - Metal Casting, ASME

MTME-104 OPERATIONS MANAGEMENT

L	T	P
4	0	0

Introduction

Basic concepts of operations and production management, Types of manufacturingsystems and their characteristics, scope of operations management.

Product and Process Design

System planning and design, long-range planning, product and process design and technological considerations, MACRO and MICRO process design.

Demand Forecasting

Role of demand forecasting in operations decisions; various demand patterns, qualitative and quantitative techniques of demand forecasting, introduction to standard software used in demand forecasting.

Production Planning and Scheduling

Aggregate production planning, operation scheduling, various scheduling criteria, lot sizing, job shop control; Mutli-stage manufacturing systems, their scheduling and management, capacity planning, introduction to standard software used for Production Planning and Scheduling.

Materials Planning

Details of material requirement planning (MRP), manufacturing resource planning (MRP-II) and enterprisewide resource planning (ERP) with their various techniques, JIT and JIT-II concepts.

Facilities Planning

Plant design, types and considerations in the plant location, plant layout types, design, evaluation, principles and types of material flow, optimum plant layout.

Books Recommended:

1. Modern Production/Operations Management by Buffa, E. S. and Sarin, R. K, John Wiley & Sons.
2. Production Operations Management by Adam, E., Jr. and Ebert, R. E., Pearson Education.
3. Operations Management: Policy, Practice, and Performance Improvement by Brown, S., Blackmon, K., Cousins, P. and Maylor H., Butterworth-Heinemann.
4. Operations Management by Dervitsiotis, K. N., McGraw Hill.
5. Production and Operations Management by Starr M. K.,Thomson Business Information.
6. Operations Management: Processes & Supply Chains by Karjewski, L. J, Ritzman, L. P. and Malhotra, M. K., Pearson Education.
7. Operations Management by S. Anil Kumar & N. Suresh, New Age International Publishers.

MTME-105 METAL FORMING

L	T	P
4	0	0

Plasticity – True stress and true strain, true stress-strain curves, selection of stress-strain curves for cold and hot working, yield of isotropic plastic material, yield criteria. Tresca maximum sheer-strainenergy criterion, plastic incompressibility, Poisson's ratio for plastic deformation flow rule, strain hardening function, heat generation and heat transfer in metal forming processes, temperatures in Quasi continuous forming operations. Examination of Metal forming processes. (12 Hours)

Drawing: Prediction of working loads and maximum deformation analysis of the processesof wire drawing/tube drawing, strip drawing and extrusion. various parameters/variables affecting the processes of wire drawing, tube drawing, strip drawing and extrusion; various methods of tube drawing and their comparison. Working loads for plain strain forging of strip and disc under conditions of well lubrications and sticking of material with die and under mixed conditions, prediction of working loads under above approach (simple plain strain and axis symmetric problems) (8 Hours)

Theory of Lubrication: Lubrication in metal forming processes, principles and mechanism of lubrications, hydrodynamic and their film lubrication, boundary and extreme pressure lubricants, solid lubricants, lubricants used for rolling and cold drawing, forging, extrusion and deep drawing processes; defects in various metal forming processes like rolling, forging, extrusion, wire drawing and deep drawing and their causes and remedial measures. (8 Hours)

Forming: Theory and deep drawing of circular blanks, analysis of the process, prediction of radial stress and punch load, ironing, wrinkling, blank holding and various parameters/variables affecting the deep drawing process. (6 Hours)

Rolling: Classification of rolling mills, analysis of the process. Prediction of roll pressure for flat strip rolling in the leading and lagging zones, roll separating forces, torque on the roll, effect of front and back tensions, effect of support rolls, various factors which affect rolling force. (6 Hours)

Books: An Introduction to the Principles of Metal working by Rowe, Arnold.

Metal forming analysis by Avitzer, Mcgraw hill.

Plasticity for mechanical Engineering by Johnson & Merlore; Van Northand.

High Velocity working Metals by ASME; EEE

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MTME-201 RESEARCH METHODOLGY

L	T	P
3	1	0

Course Objective:

The objective of the course is to enable the students to study the planning of research, strategies, tools and research ethics.

Course Outcomes:

After completing the course, the students will be able to:

CO1: Formulate the research problem

CO2: Carry out the different experimental designs and their analysis.

CO3: Apply different statistical tools for the research analysis

CO4: Follow research ethics.

Introduction to Research and Review Process

Nature and objective of research, Research topic, Literature review, Formulation of problem, Research design, Sampling techniques, Data collection, Statistical and sensitive analysis of data, Interpretation of result and report writing.

Introduction to Design of Experiment

Basic principles, Error analysis in experiments, Classification of experimental designs, Design and analysis of one, 2k and 3k factors experiments, completely randomized and randomized complete block designs

Taguchi Design and ANOVA

Taguchi method, Design of Experiments with the help of orthogonal arrays, Selection of parameters and Taguchi's Robust parameter design, Analysis of Variance, Main effects and interactions, Two-factor and three factors interaction and analysis of variance, Noise factors, Tolerance on control factors. Formation and analysis of Signal-to-Noise Ratio.

Response Surface Method and Other Approaches to Process Optimize

Introduction to response surface methodology, analysis of second order response surface, blocking in response surface design, the response surface approach to robust design, problem solution.

Statistical Software

Application of Statistical Softwares like SPSS, MS Excel, Mini Tab or MATLAB Software in Data Analysis

Research Ethics

Plagiarism tools, reproducibility and accountability.

Recommended Books:

1. Numerical Methods with Applications by Autar K Kaw, Egwu E Kalu, And Duc Nguyen
2. Design and Analysis of Experiments, Douglas C. Montgomery, John Wiley & Sons (Asia) Pvt Ltd.
3. Numerical Methods for Engineers, Chapra and Canale, 4th edition, 2005, Tata Mc Graw Hill.
4. Engineering Optimization, S.S.Rao, 3rd edition, 2000, New Age.
5. Probability and Statistics for Engineers and scientists, Walpole, Myers, Myers and Ye, 7th Edition, 2002, Pearson Education.
6. Statistics in Research, Bernand Ostle and Richard N.Mensing 3rd ed, 1975, Oxford & IBH Pub Co.
7. Research Methodology: Methods and Techniques by C.R. Kothari, Gaurav Garg , New Age international Publishers.

MTME –202 ADVANCED WELDING TECHNOLOGY

L	T	P
4	0	0

Course Objectives:

1. To impart knowledge regarding various advanced welding practices in industries.
2. To understand the different types of zones formed during welding.
3. To understand the various parameters and requirements for welding processes.
4. To know the comparative merits and demerits of various welding processes.
5. To impart knowledge of welding consumables and welding power sources.

Course Outcomes:

At the end of the course, students will demonstrate their ability to:

CO1: Describe metal transfer mechanism and classify different type of welding process on the basis of heat sources.

CO2: Analyze the mechanism of modern welding process and their Parameters and control.

CO3: Explain the influence of heat input and temperature distribution across a welded structure based on weld geometry.

CO4: Illustrate the consumables and welding power sources used for welding.

DETAILED SYLLABUS

Introduction

Classification of welding processes, weldability, welding defects, causes and remedies, weld thermal cycle, metallurgy of fusion welds, solidification mechanism and micro-structural products in weld metal, epitaxial, cellular and dendritic solidification, metallurgical changes in weld metal, phase transformation during cooling of weld metal in carbon and low alloy steel, prediction of microstructures and properties of weld metal. Heat affected zone, re- crystallization and grain growth of HAZ, gas metal reaction, effects of alloying elements on welding of ferrous metals. Welding symbols, safety and hazards in welding.

Welding Arc

Arc efficiency, temperature distribution in the arc, arc forces, arc blow, electrical characteristics of an arc, mechanism of arc initiation and maintenance, role of electrode polarity on arc behaviour and arc stability, analysis of the arc; Effects of voltage/current, polarity, welding speed on bead geometry and mechanical properties of weld.

Welding Consumables and Welding Power Sources

Classification and selection of welding electrodes and filler rods, Welding fluxes, Role of flux ingredients and shielding gases, Electrode coatings, Arc welding power sources, Basic characteristics of power sources for various arc welding processes, duty cycles, AC, DC welding power source, DC rectifiers, thyristor controlled rectifiers, transistorized units, inverter systems, Arc length regulation in mechanized welding processes.

Metal Transfer and Melting Rate

Mechanism and types of metal transfer, forces affecting metal transfer, modes of metal transfer, metal

transfer in various welding processes, effective of polarity on metal transfer and melting rate.

Advanced Welding Processes

Selection of suitable welding process, Theory, principle, technique, advantages, applications, limitations and analysis of advanced welding processes such as Electro-Slag welding, Thermit welding, Ultrasonic welding, Plasma arc welding, Electron Beam welding, Laser Beam welding, Friction welding, Friction stir welding, Forge welding, Diffusion welding, Explosive welding, Atomic hydrogen welding, Microwave welding, Hybrid welding; Resistance welding processes namely Spot, Seam, Projection, Upset, Flash welding; Other basic welding processes such as Oxy-fuel gas welding, MIG welding, TIG welding, Submerged arc welding and Allied welding processes viz. Brazing, Braze welding, Soldering.

Recommended Books:

1. R. S. Parmar, Welding Engineering and Technology, Khanna Publishers
2. P. N. Rao, Manufacturing Technology, Foundry, Forming and Welding, Tata McGraw Hill
3. Jean Cornu, Advanced Welding Systems, IFS
4. Richard L Little, Welding and Welding Technology, Tata McGraw Hill
5. Rossi, Welding Technology, McGraw Hill
6. Koenigsberger and Adaer, Welding Technology, Macmillan

MTME –203 CORROSION SCIENCE

L	T	P
4	0	0

Course Objective

The purpose of this course is to introduce the underlying science of corrosion and the fundamentals of corrosion engineering. This course will examine the general mechanisms of corrosion and relate these specific engineering issues and methods being used to reduce the cost of corrosion.

Course Outcomes:

After completing the course, the students will be able to:

CO1. Theoretical knowledge of electrochemistry and its association with corrosion.

CO2. The student is trained in distinguishing between the different corrosion forms and in proposing proper measures of prevention, right design and treatment.

CO3. The student acquires knowledge about the main corrosion forms of major alloy families, the respective routes of corrosion prevention, protection and management.

CO4. The student acquires knowledge of the effect of various environments on corrosion

DETAILED SYLLABUS

Introduction

Definition of Corrosion, Cost of corrosion, Corrosive environments, Corrosion Damage, Types of Corrosion

Corrosion Principles

Introduction, Corrosion Rate Expression, Electrochemical Aspects-Electrochemical Reactions, Polarization, Passivity, Environmental Effects-Effect of Oxygen and oxidizers, Effect of Velocity, temperature, corrosive concentration and effect of galvanic coupling

Corrosion Types-Basic Principles and Mechanisms

Uniform Corrosion, Crevice Corrosion, Pitting, Intergranular Corrosion, Selective Leaching, Erosion-Corrosion, Stress Corrosion, Hydrogen Damage

Corrosion Testing

Introduction, General Classification, Purpose of testing, Materials and Specimens, Surface preparation, Measuring & Weighing, Exposure techniques, Duration, Planned-interval tests, Aeration, Cleaning Specimens after Exposure, Standard Expression for Corrosion Rate

Corrosion Protection Methods

Classification of protection techniques, by changing physical, chemical and mechanical properties of materials, by modification of environmental parameters, cathodic and anodic protection, special coatings: metallic and nonmetallic coatings

Tutorials: Problems relevant to the topics covered in the course

Recommended Books:

1. Corrosion Engineering by Mars G. Fontana and Norbert D. Greene, Mc-Graw Hill Book Company
2. Material science and Engineering by V. Raghvan, PHI
3. Corrosion-understanding the basics by J. R. Davis, ASM Publishers
4. Engineering Coatings by Stan Grainger and Jane Blunt, Abington Publishing
5. Corrosion Testing Procedures by F. A. Champion, Chapman and Hall, London Publishers
6. Corrosion Hand Book by Herbert H. Uhlig, John-Willy Sons.

for Head
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(Main Campus) Kapurthala

MTME – 204 ADVANCED MATERIAL CHARACTERIZATION TECHNIQUES

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Course objective:

1. To provide an introduction to materials characterization and its importance.
2. To discuss different types of characterization techniques and their uses.
3. To describe the principle, operation and analysis of various advanced material characterization techniques.
4. To study the procedure of sample preparation required for various advanced material characterization techniques.
5. To discuss the application and limitations of material characterization techniques.

Course Outcomes:

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

CO1: Understand various materials characterization techniques.
CO2: Comprehend the principle and operation of characterization equipment
CO3: Decide the characterization tool for specific application
CO4: Compare the principle and operation of different characterization tools such as optical microscope, Scanning electron microscopes and transmission electron microscope
CO5: Interpret the results of various characterization techniques

DETAILED SYLLABUS

Introduction

Materials characterization - definition; importance and application. Principles and general methods of compositional, structural and defect characterization.

Diffraction Techniques

X-ray diffraction: Introduction, principles, Instrumentation, Specimen preparation, Types of analysis, Data collection for analysis, Applications, Limitations applications and limitations.

Microscopy

Optical, electron (TEM & SEM) and electron microprobe analysis, scanning probe methods (STM, AFM, EFM, MFM etc.): Introduction, principles, Instrumentation, Specimen preparation, imaging modes, applications and limitations.

Optical Spectroscopy

UV, visible, IR and Raman spectroscopy: Introduction, principles, Instrumentation, Specimen preparation, imaging modes, applications and limitations.

Electron Spectroscopy

Auger and photoelectron spectroscopy: Introduction, principles, Instrumentation, Specimen preparation, imaging modes, applications and limitations.

Thermal Methods

DTA, TGA, DSC, TMA and DMA: Basic principles, Instrumentation, working principles, Applications, Limitations.

Recommended Books:

1. Materials Characterization Techniques- Sam Zhang, Lin Li, Ashok Kumar
2. Materials Characterization-Yang Lang
3. Auger and X-ray photoelectron spectroscopy- D. Briggs and M. P. Seah
4. An Introduction to Material Characterization- P. R. Khangaonkar
5. Materials Characterization, ASM Hand Book Vol. 10, Edited by: ASM International Handbook

for Ambedkar
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MTME-301 INDUSTRIAL AUTOMATION

Course Learning Objectives:

The basic objective of the subject is:

1. To introduce the importance of automation techniques manufacturing and process industries.
2. To impart the role of PLC in industry automation.
3. To expose to various control techniques employed in process automation.
4. To develop automation system for manufacturing and process industries.

Course Outcomes

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

CO1 familiar with various automation technologies in manufacturing and process industries.
CO2 understand various automation tools and methods in manufacturing industry.
CO3 implement various control and automation method in process industries.
CO4 familiar with various communication technologies in manufacturing and process industries.

DETAILED SYLLABUS

Automation in Manufacturing Industries: - Introduction- Automation in production system, Principles and strategies of automation, Basic elements of an automated system, Advanced automation functions, Levels of automations, Automated flow lines and transfer mechanisms, Analysis of transfer lines without storage, Automated flow lines with storage buffers.

Material Handling and Identification Technologies: - Overview of material handling systems, Types of material handling equipment, Design of the system, Conveyor system, Automated guided vehicle system, Automated storage systems, Interfacing handling and storage with manufacturing, Overview of Automatic Identification Methods.

Automated Manufacturing Systems:- Components, Classification and overview of manufacturing systems, Cellular manufacturing, Flexible manufacturing system(FMS), FMS and its planning and implementation, Automated assembly system – design and types of automated assembly systems, Analysis of multi station and single station assembly machine.

Automation in Process Industries:- Introduction to computer based industrial automation- Direct Digital Control (DDC), Distributed Control System (DCS) and supervisory control and data acquisition (SCADA) based architectures. SCADA for process industries includes understanding of RTUs, Pumping stations, Evacuation processes, Mass Flow Meters and other flow meters, Leak-flow studies of pipelines, Transport Automation.

Programmable Logic Controller (PLC):- Block diagram of PLC, Programming languages of PLC, Basic instruction sets, Design of alarm and interlocks, Networking of PLC, Overview of safety of PLC with case studies. Process Safety Automation: Levels of process safety through use of PLCs, Integrating Process safety PLC and DCS, Application of international standards in process safety control.

Distributed Control System:- Local Control Unit (LCU) architecture, LCU Process Interfacing Issues, Block diagram and Overview of different LCU security design approaches, Networking of DCS. Introduction to communication protocols- Profibus, Field bus, HART protocols. Data gathering, Data analytics, Real-time analysis of data stream from DCS, Historian build, Integration of business inputs with process data, Leveraging RTU (as different from PLCs and DCS).

Reference Books:

1. M.P.Groover,"Automation, Production Systems and Computer Integrated Manufacturing", 5 th Edition, Pearson Education, 2009.
2. John W. Webb and Ronald A. Reis, "Programmable Logic Controllers: Principles and Applications", 5th Edition, Prentice Hall Inc., New Jersey, 2003.
3. Krishna Kant, "Computer - Based Industrial Control", 2nd Edition, Prentice Hall, New Delhi, 2011.
4. Frank D. Petruzella, "Programmable Logic Controllers", 5th Edition, McGraw- Hill, New York, 2016.
5. Curtis D. Johnson, "Process Control Instrumentation Technology", 8th Edition, Pearson New International. 2013
6. Lukas M.P, " Distributed Control Systems", Van Nostrand Reinhold Co., New York, 1986

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MTME-302 MECHATRONICS & IOT

Course Learning Objectives:

The basic objective of the subject is:

1. To understand basic concept of Mechatronics and IOT.
2. To understand function of basic IOT components, cloud platform and interfacing with real time applications.
3. To impart knowledge on tools and techniques used for developing IOT based products

Course Outcomes

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

1. Ability to develop IOT application using controller, sensors, actuators etc.
2. Ability to develop application using cloud and data analytics.
3. Ability to develop IOT mobile application

List of Practicals

1. Study and demonstration of Mechatronics and IOT-based components.
2. Demonstration of microcontroller and microprocessor for various applications.
3. To carry out Interfacing of I/O devices.
4. Demonstration of integration of hardware and software with IoT cloud.
5. Car reverse assistant system
6. Home Automation by Voice Control & Remote Control
7. Smart Agriculture using remote monitoring and control for Soil condition and pump operation
8. IOT application using cloud platform and Data Analytics
9. To carry out the project based on IoT i.e., turn your smartphone into an IoT device using the IoT Platform cloud-hosted service.

MTME-205 TRIBOLOGY

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Course Objective:

The basic objective of the subject is:

1. To provide the knowledge and importance of Tribology in Design, friction, wear and lubrication aspects of machine components.
2. To understand the principles of lubrication, lubrication regimes, theories of hydrodynamic and the advanced lubrication techniques.

Course Outcomes:

After successful completion of this class, students will be able to

CO1. Apply the basic theories of friction, wear and lubrication to predictions about the frictional behavior of commonly encountered sliding interfaces.

CO2. Characterize features of rough surface and liquid lubricants as they pertain to interface sliding.

CO3. Interpret the latest research on new topics in tribology including its application to nanoscale devices and biological systems

DETAILED SYLLABUS

Introduction

Background, Meaning of tribology, Cost of friction and wear, Types of contacts, Types of motions, Types of deformations, Surface energy and flash temperature theory, Interdisciplinary approach.

Friction and Wear

Topography of engineering surfaces, Material properties influencing friction, Cause/source of friction, Laws of friction, Friction characteristics, Friction of metals, non-metals, lamellar solids, ceramics and polymers, Energy dissipation mechanism, Stick-lip motion, Measurement of friction, Types of wear: abrasive, erosive, cavitation and adhesive wear , Wear mechanism, Theories of wear, Friction effecting wear, Wear of metals and non-metals, ceramics and polymers, Wear measurements in dry and wet environments and Wear equipment.

Lubrication

Importance, Types and mechanism of lubrication, squeeze film, hydro-static, hydrodynamic, elasto-hydrodynamic and plasto-hydrodynamic lubrication, Solution of Reynold's equation in two and three dimensions, Pressure distribution, load carrying capacity and friction forces in oil films, Coefficient of friction in Journal bearing, A brief introduction of solid lubricants and their applications.

Tribology of Bearings

Principle, Operations and Selection Criteria: : hydrodynamic bearing, hydrodynamic journal bearing, hydrostatic bearing, rolling element, ball bearing, roller bearing, needle roller bearing, Design of bearing/journal bearing, Clearance in journal bearing, Minimum film thickness,

Sommar-field number, Heat generation and cooling.

Industrial Applications of Tribology

In metal working: effect of friction, Classification of plastic deformation in rolling, drawing, extrusion, forging, sheet-metal, metal removaland metal finishing, Lube share in metal working process, In Mining: Tools and cutters, Tribology in excavation, loading, haulage and hoisting, In paper and glass fibre industry.

Recommended Books:

1. Prasanta Sahoo, Engineering Tribology, PHI Learning Private Limited
2. Sushil Kumar Srivastava, Tribology in Industries, S. Chand and Company Limited
3. B. S. Prabhu, Industrial Tribology, Tribological Failure and Their Analysis
4. Gwidon W. Stachowiak and Andrew W. Batchelor, Engineering Tribology

MTME – 206 INDUSTRIAL ROBOTICS

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Course Objective

The objective of this course is to introduce the basic concepts in Robotics, robot kinematics, sensors, effectors, control systems.

Course Outcomes

The students would be able to:

CO1 Interpret terminologies related to Robotics technology.
CO2 Understand various grippers and sensors for robotics.
CO3 Apply logic for selection of robotic sub systems and systems
CO4 Analyze basics of principles of robot system integration.
CO5 Integrate knowledge of AI techniques in the area of robotic technology.

DETAILED SYLLABUS

Introduction to robotics : Brief History, Basic Concepts of Robotics such as Definition , Three laws, Elements of Robotic Systems i.e. Robot anatomy, DOF, Misunderstood devices etc., Classification of Robotic systems on the basis of various parameters such as work volume, type of drive, etc., Associated parameters i.e. resolution, accuracy, repeatability, dexterity, compliance, RCC device etc., Introduction to Principles & Strategies of Automation, Types & Levels of Automations, Need of automation, Industrial applications of robot.

Grippers and Sensors for Robotics:

Grippers for Robotics - Types of Grippers, Guidelines for design for robotic gripper, Force analysis for various basic gripper system. Sensors for Robots - Types of Sensors used in Robotics, Classification and applications of sensors, Characteristics of sensing devices, Selections of sensors. Need for sensors and vision system in the working and control

Drives and Control for Robotics:

Drive - Types of Drives, Types of transmission systems, Actuators and its selection while designing a robot system. Control Systems: Types of Controllers,

Programming and Languages for Robotics: Robot Programming: Methods of robot programming,WAIT, SIGNAL and DELAY commands, subroutines, Programming Languages: Generations of Robotic Languages, Introduction to various types such as VAL, RAIL, AML, Python, ROS etc., Development of languages since WAVE till ROS.

Related Topics in Robotics: Socio-Economic aspect of robotisation. Economical aspects for robot design, Safety for robot and standards, Introduction to Artificial Intelligence, AI techniques, Need andapplication of AI, New trends & recent updates in robotics.

Recommended Books:

1. Robotics by Appuu Kuttan K. K., I K Internationals.
2. Introduction to Robotics by S K Saha , New York, Mc Graw Hill
3. Asitava Ghoshal, Robotics: Fundamental concepts and analysis, Oxford University Press (2006).
4. Dilip Kumar Pratihar, Fundamentals of Robotics, Narosa Publishing House, (2019).
5. R. K. Mittal, I. J. Nagrath, Robotics and Control, TATA McGraw Hill Publishing Co Ltd, New Delhi (2003).

MTME-207 PLASTIC ENGINEERING

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Course Objective

1. To evaluate the properties and processing methods for commercial plastic materials.
2. To evaluate the different methods of processing plastics in terms of their fundamental advantages and disadvantages from a product design perspective.
3. To evaluate the effect various additives have on changing the performance of a commercial resins.
4. To provide an appreciation of the environmental, life cycle and recycling issues related to the use of plastics.

Course Outcomes

After completing the course students will be able to:

1. Knowledge of variety of methods used to process commercial plastic resins, including limitations.
2. Knowledge of the basic tooling requirements for various plastic processing methods.
3. Ability to write professionally formatted summaries of plastic processing experiments.
4. Articulate the roll of additives in changing the performance of commercial resin systems.

DETAILED SYLLABUS

Overview of the Plastics Industry

Major processes and products, Classification methods of commercial resins, Net-shaped manufacturing

Process Selection

Extrusion, Injection Molding (and variations) – with in-depth analysis of process physics, Thermoforming, Blow Molding (Injection and Extrusion), Rotational Molding, Compression Molding and Filament Winding (reinforced thermosets), Tooling requirements for each process

Plastics Material Selection

Classification based on cost, resistance to chemicals, performance under loads and heat
Commodities: HDPE, LDPE, PP, PS, and PVC (low cost thermoplastics)
Roll of additives in modifying resin performance. Plastics combinations of Polymers and Additives (for performance, protection, esthetics)
Engineering: PC, PMMA, PA, POM (higher cost and performance thermoplastics)
High temperature: PTFE, PEI, PSU, PPS (very high temperature thermoplastics)
Elastomers (partial cross-linking): PUR and SI
Thermosets: PF, MF, UP, and EP (much cross-linking)
Bio-based: PLA; renewable feedstock vs. compostable products

Life Cycle Analysis and Recycling

Role of plastics in sustainable living, End of life options for commercial resins

Recommended Books:

1. Osswald and Menges, Materials Science of Polymers for Engineers, Hanser (1995) (introductory material science)
2. Pötsch and Michaeli, Injection Molding an Introduction, Hanser (1995) (practical and theory

based reference)
3. Osswald, Polymer Processing Fundamentals, Hanser (1998) (introductory processing overview)
4. Avery, Injection Molding Alternatives, Hanser (1998) (comprehensive treatment of alternatives to molding)
5. Progelhof and Throne, Polymer Engineering Principles, Hanser (1993) (deep, theoretical treatment of processing/design)
6. Ehrenstein, Polymeric Materials, Hanser (2001) (excellent foundational treatment of polymeric materials)

MTME – 208 RAPID PROTOTYPING

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Course Objective
To provide knowledge on different types of Rapid Prototyping systems and its applications in various fields.

Course Outcomes
At the end of the course, the student will be able to

CO1: Describe product development, conceptual design and classify rapid prototyping systems; Explain stereo lithography process and applications.

CO2: Explain direct metal laser sintering, LOM and fusion deposition modeling processes

CO3: Demonstrate solid ground curing principle and process

DETAILED SYLLABUS

Introduction to Rapid Prototyping
Classification of Manufacturing Processes, Introduction to Rapid Prototyping, Rapid Prototyping and its Impact, Engineering design process, Product development, Product Prototyping and Product Development, Need of Product Prototyping, Prototype Planning and Management, Product and Prototype Cost Estimation, Prototype Design Methods and tools.

Materials Selections and Product Prototyping
Geometrical Modelling Techniques, Wireframe Modelling, Surface Modelling and solid modelling, Prototyping Materials, Modelling of Material Properties, Modelling and Design of Materials and Structures.

Rapid Prototyping Processes
Rapid Prototyping Overview, Rapid Prototyping Procedure, Liquid-Based RP Processes, Solid-Based RP Processes, Powder-Based RP Processes.

Direct Digital Prototyping and Manufacturing
Solid Models and Prototype Representation, Reverse Engineering for Digital Representation, Prototyping and Manufacturing Using CNC Machining, Fully Automated Digital Prototyping and Manufacturing.

Direct Methods for Rapid Tool Production
Classification of Direct Rapid Tool Methods, Direct ACESTM Injection Moulds, Laminated Object Manufactured (LaM) Tools, DTM Rapid Tool, Sand Form, EOS Direct Tool Process, Direct Metal Tooling using 3Dp. applications of Rapid Prototyping: Functional Models, Pattern for Investment and Vacuum Casting, Medical Model, and Art Models, Engineering Analysis Models

Indirect Methods for Rapid Tool Production
Metal Deposition Tools, RTV Tools, Epoxy Tools, Ceramic Tools, Cast Metal Tools, Investment Casting, Fusible Metallic Core, Sand Casting, Keltool Process

Recommended Books:

- Rapid prototyping and engineering applications by Frank W. Liou, CRC press publications.
- Rapid manufacturing by DT Pham & SS Dimov, Springer
- Product design by Kevin otto &, kristin wood, Pearson publication

MTME – 209 ADVANCED METAL CUTTING

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Course Objectives:

1. The course provides students with fundamental knowledge and principles in material removal processes.
2. In this course, the students apply the fundamentals and principles of metal cutting to practical applications through multiple labs using lathes, milling machines, grinding machines, and drill presses, Computer Numerical Control etc.
3. To demonstrate the fundamentals of machining processes.
4. To develop knowledge and importance of metal cutting parameters.
5. To develop fundamental knowledge on tool materials, cutting fluids and tool wear mechanisms.
6. To apply knowledge of basic mathematics to calculate the machining parameters for different machining processes.

Course Outcomes:

After studying this course, students shall be able to:

CO1.Overview of the principles of metal cutting
CO2. Describe the methods of metal cutting
CO3. Describe the cutting forces involved and their measurements
CO4. Describe the parameters effecting tool forces
CO5. Describe the theory/methods to find tool life.

DETAILED SYLLABUS

Introduction

Machining fundamentals: work-tool contact, machinable surface, Kinematics of work tool interaction, kinematic elements involved in metal cutting action during different processes, Steriometry of cutting tools: basic shape of cutting tool, tool in hand and system of Tool Nomenclature, standards, Tool Geometry, tool point reference system. Method of master line for rake angle, vector method for rake angle inter relationship.

Oblique Cutting

Normal chip reduction coefficient under oblique cutting, True shear angle, effective rake, influx reg on consideration for deformation. Direction of maximum elongation, effect of cutting variables on chip reduction coefficient, Forces system in oblique cutting, effect of wear land on force system. Force system in milling, effect of helix angle, vulf's method, spaan's model for oblique cutting.

Mechanism of Chip Formation

Deformation of uncut layer in shear, Methods for frozen chip samples, classification of chips, mechanics of chip curl, factors involved in chip formation analysis, Dynamic shearing strain in chip formation, Effect of nose radius, effect of cutting variables on chip reduction coefficient.

Cutting Forces and Dynamometer

Measurement of forces, basic requirement in force measuring techniques, transducers for force measurement, design requirement of dynamometers, different types of force measuring instruments, dynamics of dynamometers, dynamometers for measurement of forces during turning, drilling and milling. Effect of cutting variables on cutting forces. Theoretical determination of cutting forces: Ernst and Merchants upper bond solution, Merchant's second solution and machining constant.

Fundamental Factors Which Effect Tool Forces

Correlation of standard mechanized test. (Abuladze-relation), nature of contact and stagnant phenomena, Rates of strains, shear strain and normal strains distribution, Kinetic coefficient of friction analysis, Built up edge phenomena, Effect of cutting variables on BUL and BUE.

Failure of Cutting Tools

Tool materials, tool failure, analysis of plastic failure (Form stability criterion), Analyzing failure by brittle fracture, wear of cutting tools, criterion, Flank and creature wear analysis, optimum tool life, tool life equations (Taylor's, woxen etc.) Tool life test, machining optimization predominant types of wear: flank, crater, abrasive, adhesive, diffusion wear models, wear measurements techniques, Theory of tool wear, oxidative, Mathematical modeling for wear, Test of machinability and influence of metallurgy on machinability.

Economics of Machining

Economic tool life; Gilbert's Model, Optimal cutting speed for Maximum production; Maximum profit cutting speed, objective criteria for optimization, selection of optimum cutting parameters under various restrictive conditions, Brewer and Reuda;s optimization for maximum power constraint and maximum feed, Bjrcke's Generalized Model, Sensitivity analysis in Machining economics, Economy based on Non Taylorian Tool life laws; Economics of multipass cutting.

Advance Metal Machining

Composite cutting, ceramic and super alloys cutting, cutting tool selection, process parameters and geometry effect on machinability during cutting of composite, ceramics and super alloys.

Surface Integrity and Finishes

Surface metallurgy and topography, factors affecting the surface quality, the numerical assessment of the machined surface, ISO recommendation for assessment of machined surface, super finishing processes, and kinematics of super finishing. Mechanics of lapping and honing, three body abrasion.

Books Recommended:

1. Metal cutting theory and practice by A. Bhattacharyya, Central book, Publisher, Calcutta-9
2. Metal cutting by M. Shaw
3. Manufacturing Science by Amitava Ghosh, and Asok kumar Mallik, Affiliated East-West Press Private Limited, New Delhi

MTME-210 COMPUTER AIDED DESIGN & MANUFACTURING

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Course Objectives:

To review and train in CAD/CAM modeling by introducing the concepts of geometric & solid modeling techniques, automated CNC machining, and process control

Course Outcomes:

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

CO1 Understand the basic fundamentals of computer aided design and manufacturing

CO2 To learn 2D & 3D transformations of the basic entities like line, circle, ellipse etc.

CO3 To understand the different geometric modelling techniques like solid modelling, surface modelling, feature based modelling etc. and to visualize how the components look like before its manufacturing or fabrication

CO4 To learn the part programming, importance of group technology, computer aided process planning, computer aided quality control

CO5 To learn the overall configuration and elements of computer integrated manufacturing systems.

DETAILED SYLLABUS

CAD

Introduction

Definitions, Historical Development. Nameable and Unnamable shapes, Explicit and Implicit Equations, Intrinsic Equations, Parametric Equations, Coordinate Systems.

Curves

Algebraic and Geometric Forms, Parametric space of a curve, Blending functions, Re-parametrization, Truncating, Extending and subdividing, Space curve, Four point form, Straight lines, Spline Curves, Bezier Curves, B-spline Curves, Rational Polynomials. introduction to NURBS.

Geometric Transformation and Projection

Transformations: Translation, Rotation, Scaling Symmetry and Reflection, Homogeneous Transformations. Orthographic Projections, Axonometric Projections, Oblique Projections, Perspective Transformation.

Surfaces

Algebraic and Geometric form, Tangent and Twist Vectors, Normal, Parametric space of a surface, Blending Functions, Re-parametrization of a surface patch, subdividing, Sixteen Point form, 16 Four Curve Form, Plane surface, Cylindrical Surface, Ruled surface, Surface of Revolution. Bezier Surface, B-Spline Surface.

CAM

Introduction to Computer Aided Design (CAD), Computer Aided Process Planning (CAPP), Computer Aided Manufacturing (CAM), Computer Integrated Manufacturing (CIM), product cycle and automation in CAD/CAM, Need of CAD/CAM.

Process Planning

Basic concepts of process planning, computer aided process planning (CAPP), Retrieval or variant and generative approach of CAPP, Implementation consideration of CAPP.

Numerical control of Machine tools

Principles of Numerical control (NC), Computer Numerical control (CNC), Direct Numerical control (DNC), comparison between conventional and CNC systems, Classification of CNC system, NC coordinate system, positional control, system devices; drives, ball screws, transducers, feedback devices, counting devices, signal converters, interpolators, adaptive control system.

NC Part programming

Concept, format, codes, preparatory and miscellaneous coded, manual part programming, APT

programming, macros, fixed cycles.

Group Technology (GT)

Introduction, needs of GT, part families, classification and coding systems, GT machine cells, benefits of GT.

CIM and FMS

Introduction, hierarchical computer system, components of CIM, types of manufacturing systems, transfer lines, flexible manufacturing system (FMS), The manufacturing cell, tool management and workpiece handling system, benefits of CIM.

Books Recommended:

1. Michael E. Mortenson, Geometric Modelling: John Wiley.
2. Roger and Adams, Mathematical Elements of Computer Graphics: McGraw Hill.
3. I. Zeid, CAD CAM Theory and Practice: McGraw Hill.
4. Groover Automation, Production systems and computer integrated manufacturing PHI.
5. Groover and Zimmer CAD/CAM PHI Chang, Wysk & Wang, Computer Aided Manufacturing: PHI.
6. Yoram Koren, Computer control of manufacturing system: McGraw Hill Book Co.
7. B.L. Jones, Computer Numerical Control: John Wiley and Sons.
8. Rao, Tiwari & Kunda, Computer Aided Manufacturing: Tata Mc.Graw Hill.
9. Vajpayee, Principles of Computer Integrated Manufacturing: PHI.
10. Radhakrishna Subramanyan & Raju, CAD/CAM/CIM: New Age International (P) Ltd., Publishers.
11. Sharma, Fundamentals of Computer aided Manufacturing: S.K. Kataria and Sons.

MTME – 211 MAINTENANCE AND RELIABILITY ENGINEERING

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Course Objectives:

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

Course Outcomes:

After studying this course, students shall be able to:

CO1. Understand the concepts of Maintenance, Reliability and Availability.

CO2. Establish maintenance strategies according to system characteristics and design transition programs to implement these strategies.

CO3. Develop fault trees for a system and apply various reliability models on fault analysis.

CO4. Develop hazard rate models to know the behaviour of components.

CO5. Manage the manufacturing organisation with highest possible availability.

DETAILED SYLLABUS

Introduction

Concept of maintenance and terotechnology, objective and importance of maintenance engineering, functions and classification, types of maintenance: corrective, renovative, preventive, breakdown, planned, proactive, predictive etc.

Maintenance Planning and Control

Basic requirements of maintenance systems, responsibilities of maintenance engineering department, control and coordination in maintenance, Maintenance planning, Daily/monthly/annually maintenance schedule, Format/preparation of equipment history, failure analysis report, daily maintenance progress report, Total productive maintenance (TPM)

Safety and House Keeping in Maintenance

Hazards: classification, important factors of hazards and causes of accidents, categories of hazards and measurement, procedure of minimizing hazard, different safety devices, their applications and safety checklist. Factors governing housekeeping, housekeeping maintenance and inspection.

Reliability and Hazard Rates

Reliability, maintainability, failure, hazard rate concept, availability, Reliability structure and optimum design configuration of series, parallel, combination of series and parallel, redundancy structure. Mean time to failure (MTTF), mean time between failures (MTBF), mean time to repair (MTTR). Breakdown time distribution. 5-WHY concept for root cause.

Reliability Prediction and Analysis

Quantitative estimation of reliability: Kuder-Richardson formula, Statistical estimation of reliability. ReliaSoft's Lambda hybrid automated reliability predictor. Reliability prediction

based on exponential distribution, system reliability analysis – block diagram method, fault tree and success tree methods, event tree method, failure model, failure mechanism.

Reliability Design

Design for reliability, design process, assessment methodology, reliability allocation, reliability improvement, selection of components to improve system reliability.

Recommended Books:

1. Industrial Engineering and Management Khanna O.P Dhanpat Rai & Sons 1994
2. A textbook of Reliability and Maintenance Engineering by Dr. Alakesh Manna, I K International.
3. Maintenance Planning and Control, Kelly A Buttersworth & Co. 1984
4. Maintenance and Spare parts Management, Krishnan G. Prentice Hall 1991
5. Reliability Engineering and Technology, Gupta, A.K Macmillan India Ltd. 1996
6. Introduction to Reliability Engineering Lewis E.E John Willey & Sons
7. Reliability Engineering, Srinath L.S., East West Press 1991

MTME – 212 SUPPLY CHAIN MANAGEMENT

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Course Objectives

1. To develop an understanding of basic concepts and role of Logistics and supply chain management in business.
2. To understand how supply chain drivers play an important role in redefining value chain excellence of Firms.
3. To develop analytical and critical understanding & skills for planning, designing and operations of supply chain.
4. To understand, appraise and integrate various supply chain strategies.

Course Outcomes:

At the end of the course, students will demonstrate their ability to:

CO1 Explain the fundamentals of elements and functions of supply chain, role of drivers and demand forecasting. To understand how supply chain drivers play an important role in redefining value chain excellence of Firms.

CO2 Apply various techniques of inventory management and their practical situations.

CO3 Analyze how supply chain decisions related to facility location can be applied to various industries and designing the supply chain.

CO4 How various warehousing management system and transportation can be practiced in various industries?

CO5 How supply chain performance can be measured using various models?

DETAILED SYLLABUS

Supply Chain Drivers and Obstacles

Four drivers of supply chain inventory transportation, facilities, and information, a framework for structuring drivers, role of each driver in supply chain, obstacles to achieve strategic fit.

Supply Chain Performance

Objectives of supply chain, stages of supply chain, supply chain process cycles, customer order cycle, replenishment cycle, manufacturing cycle, procurement cycle, push/pull view of supply chain processes, importance of supply chain flows, examples of supply chain, supply chain strategies, achieving strategic fit, product life cycle, the minimize local cost view, the minimize functional cost view, the maximize company profit view, the maximize supply chain surplus view.

Managing Economies of Scale in A Supply Chain

Role of cycle inventory in a supply chain, economies of scale to exploit fixed costs, economies of scale to exploit quantity discounts, short term discounting, estimating cycle inventory related costs, determining appropriate level of safety inventory.

Transportation in A Supply Chain

Facilities affecting transportation decisions, modes of transportation and their performance

characteristics, design options for a transport network, trade-offs in transportation decision, tailored transportation, routing and scheduling in transportation, making transportation decisions in practice.

Logistics and Competitive Strategy
Competitive advantage, gaining competitive advantage, advantage through logistics, mission of logistics management, supply chain and competitive performance, changing logistics environment.

Measuring Logistics Costs and Performance
The concept of total cost analysis, principles of logistics costing, logistics and the bottom line, logistics and share holder value, customer profitability analysis, cost drivers and activity based costing.

Benchmarking the Supply Chain
Benchmarking the logistics process, mapping supply chain processes, supplier and distributor benchmarking, identifying logistics performance indicators, setting benchmarking priorities.

Coordination in A Supply Chain
Lack of supply chain coordination and the Bullwhip effect, effect of lack of coordination on performance, obstacles to coordination, managerial levers to achieve coordination, achieving coordination in practice.

Recommended Books:

1. Logistics and Supply Chain Management by Martin Christopher, Pearson Education Asia (2002).
2. Supply Chain Management–Strategy, planning and operation's, by Peter Meindl Pearson Education, Asia.
3. Marketing logistics: A Supply Chain Approach, by KK Kapoor & P Kansal Pearson Education Asia.
4. Production and operation Management by Alan Muhlemann, John Oakland & Keith Lockyer Macmillan India Publications (2000).
5. Production and Operations Management by K. Aswathappa, & K.S.Bhat, Himalaya Publishing House, Mumbai (2000).
6. Production and operations Management by R. Panneerselvan, Prentice Hall of India, Delhi.
7. Essentials of Supply Chain Management by S.G. Deshmukh.

MTME-213 PRODUCTION PLANNING AND CONTROL

L	T	P
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Course Objective
The objective of the course is to enable the students to study basic strategies of production planning and its controlling methods. It also includes resource planning, shop floor planning

Course Outcomes
After completing the course students will be able to:
CO1: Forecast the appropriate requirement of resources for various production processes and other shop floor activities.
CO2: Design an appropriate strategy for resource planning through appropriate MRP tool
CO3: Improve the productivity of shop floor through design of appropriate production systems such as mass production, batch production etc. within existing conditions.
CO4: Apply scientific tools such as MRP, JIT optimizing production systems.

DETAILED SYLLABUS

Introduction: Manufacturing function; Elements of production systems; Types of production systems, objectives and functions of production planning and control, concept of production and productivity.

Product Design: Identification of product ideas and selection, product development and design; Product analysis: Marketing aspects, product characteristics, economic analysis, profitability and competitiveness, production aspects.

Process Design: Systems approach to process planning and design, linkage, distinction between process planning and facilities planning, types of process design, product mix, process planning aids. Forecasting: Concepts and applications, demand forecasting, principle of forecasting;

Forecasting techniques: Quantitative and qualitative

Aggregate Planning: Concept, strategies for aggregate planning: three pure planning strategies, master production scheduling (MPS), and procedure for developing MPS

Capacity Planning and Facility Design: Importance of Capacity and Location decisions, Measuring Capacity, Capacity Strategy, Capacity Planning and Evaluation Methods. Facility location factors, evaluation of alternatives, Types of plant layout, evaluation, Computer aided layout, Assembly line balancing

Shop floor planning and control: Phases in production planning and control, operations planning and scheduling, scheduling techniques for job shop, stages in scheduling, load charts, Sequencing concept-job machine problems

Lean Production System: Kanban and Pull system, Implementation of JIT Production

Resource Requirements Planning: MRP-I, MRP-II, MRP Computational procedure, issues in MRP, evaluation of MRP, Introduction to ERP.

Inventory: functions, costs, classifications, deterministic and probabilistic inventory models, quantity discount; perpetual and periodic inventory control systems.

Recommended Books:

1. Buffa, E.S., and Sarin, R.K., "Modern Production / Operations Management", John Wiley & Sons,1994
2. Mukhopadhyaya, S.K., "Production Planning and Control – Text and Cases", PrenticeHall of India,2004
3. Adam, Jr., E.E., and Ebert, R.J., "Production and Operations Management: Concept, Models and Behavior", 5th Ed., Prentice-Hall of India, 2001
4. Vollman, T.E., Berry, W.L., and Why bark, D.C., "Manufacturing Planning and Control Systems" 4th Ed., McGraw-Hill, 1997
5. Sipper, D., and Buffin, R.L., "Production: Planning, Control and Integration", McGrawHill, 1997

ONLINE RESOURSES 1. nptel.ac.in/courses/112107143/

MTME – 214 PRODUCT DESIGN AND DEVELOPMENT

L	T	P
4	0	0

Course Objectives:

The focus of Product Design and Development is integration of the marketing, design, and manufacturing functions of the firm in creating a new product. The course is intended to provide you with the following benefits:

1. Competence with a set of tools and methods for product design and development.
2. Confidence in your own abilities to create a new product.
3. Awareness of the role of multiple functions in creating a new product (e.g. marketing, finance, industrial design, engineering, production).
4. Ability to coordinate multiple, interdisciplinary tasks in order to achieve a common objective.
5. Reinforcement of specific knowledge from other courses through practice and reflection in an action-oriented setting.
6. Enhanced team working skills.

Course Outcomes:

After studying this course, students shall be able to:

CO1. Learn the importance of product design in industry and principal requirements of good product design.
CO2. Learn the knowledge about the ergonomic factor in product design and product design methodology and techniques.
CO3. Learn the knowledge about the basic elements and concepts of visual design.
CO4. Learn the importance of product graphics, product development and packaging of materials.
CO5. Learn how the product design helps in to reduce the time to launch product in market.

DETAILED SYLLABUS

Creative Thinking and Organizing for Product Innovation

The product design function, locating ideas for new products, selecting the right product, Qualifications of the product design engineer, Creative thinking, Curiosity and imagination, Ideas generate ideas, taking time to think, Using a systematic producer for product innovation, Setting responsibilities for new product development, Structural units for new product development, Functions of the new product development unit, Opportunities for the product design engineer.

Criteria for Product Success

Areas to be studied preparatory to design, Principles of values and laws of appearance, Incorporating quality and reliability into the design, Man-machine consideration, Designing for ease of maintenance.

Cost and Product Development

Source of funds for development cost product costs, Estimating the product cost, Kinds of cost procedures, Cost reduction.

Integrated Approach to Product Development

Diffusion of innovation. Generation, screening and development of new product ideas, Product life cycle and new product development, Economic analysis-evaluation of new product ideas/concepts, Value analysis, Test marketing of new product launch.

Recommended Books:

1. Product design and Manufacturing by Chitale and Gupta, Prentice Hall 1997.
2. Taguchi Methods Explained by Bagchi, Prentice Hall 1997 (Practical steps to robust design).
3. Product design and process Engineering by Nible & Drper, Mc Graw Hill.
4. Design and Marketing of new products by Urban G.L & Houser, Prentice Hall 1980
5. Marketing management by Kotler Phillips, Prentice Hall 1990
6. New product Development by Mascarenhas Oxford, 1987 (it is Marketing Research & Managerial Calculate)
7. Product Management by Kaushal O.P & Lalvani Pub. House, 1967
8. The Management of Innovation Burns & Stalk Tasstoch Publication, 1961

MTME-215 ENTREPRENEURSHIP

L	T	P
4	0	0

Course Objectives

The purpose of this subject is to prepare a ground where the students view Entrepreneurship as a desirable and feasible career option. In particular, the paper seeks to build the necessary competencies and motivation for a career in Entrepreneurship

Course Outcomes

After studying this course, students shall be able to:
CO1 Gain knowledge of discovering opportunities and basic entrepreneurial issues.
CO2 Develop critical thinking skills on developing a career as entrepreneurs and define the concept of entrepreneurship.
CO3 Understand strategic decisions that entrepreneurs need to make and the ability to engage in strategic planning.
CO4 Develop the ability to solve real life entrepreneurship issue and Small/ Medium Business problems.

DETAILED SYLLABUS

Foundations of Entrepreneurship: Entrepreneurship and Intrapreneurship- similarities and variance, India's start up Revolution: Trends, Imperatives, Characteristics and types of entrepreneurs, Business vs. Enterprise, different forms of ownership, Business incubators- Rural Entrepreneurship, Social entrepreneurship, Women Entrepreneurship- The Entrepreneurial mind set. Key attributes of an entreprencur, Desirable and acquirable attitudes and behaviours- Readiness- The right time, right age and right conditions- Myths & realities of Entrepreneurship.

Entrepreneurship Composition/Development: Entrepreneurial Stress. Composition of Entrepreneurship, Different life stages of entrepreneur, relative importance – Disagreements between Entrepreneurs, idea entrepreneur and where do ideas come from. Scarcity, Choice and Trade off- Identity paying customer, developing market understanding- Narrowing focus- End user profiling and Persona- Market Segmentation, Market sizing. Institution and schemes offered to promote entrepreneurship in India.

Enterprise Scalability/ Legal Structures and Matters: Small & Medium Business, Scalability, Defensibility, Venture feasibility analysis- Pitching Legal Matters- Organizational Form Partnership, Sole Proprietorship. Corporation, Intellectual Property- Copyright, trademarks - Tax, Personal Law.

Start Ups: Ideation, feasibility study - technical and financial feasibility, business plan and DPR preparation, Concept of Business Plan, Scope and Value, Writing the business plan, Using and implementing business plan.

Recommended Books:

1. Entrepreneurship development programme in India and its relevance to developing countries by VG Patel; EDI- India; Ahmedabad (1987)
2. Developing of New Entrepreneurship by EDI India; Ahmedabad (1987)
3. Self –made Impact making Entrepreneurship by G.R. Jain and M.A. Ansari; by EDI India; Ahmedabad (1988)
4. Vasant Desai Management of small scale industries, Himalaya Publishing
5. Angadi, Cheema, Das, Entrepreneurship, Growth, and Economic Integration, Himalaya Publication
6. Roy Entrepreneurship Oxford University Press 4) Dr. R.K Gupta & Lipika k.Guliani Fundamen

MTME-216 WORK SYSTEM DESIGN AND ERGONOMICS

L	T	P
4	0	0

Course Objective

The basic objective of this course is:

1. To provide basic understanding to the students about the concept and significance of work study and ergonomics.
2. To impart thorough knowledge to the students about various techniques of work-study for improving the productivity of an organization.
3. To inculcate the skill among the students for analyzing and improving existing methods of working on the shop floor of an organization.
4. To impart through knowledge and skills to students with respect to allowances, rating, calculation of basic and standard time for manual operations in an organization.

Course Outcomes

After studying this course, students shall be able to:

CO1: Students will be able to calculate the basic work content of a specific job for employees of an organization. Thereby they will be able to calculate the production capacity of man power of an organization.
CO2: Students will be able to analyze and calculate the level of risk in a job causing stress, fatigue and musculoskeletal disorders and design appropriate work systems.
CO3: Students will be able to rate a worker engaged on a live job and calculate basic, allowed and standard time for the same

DETAILED SYLLABUS

Work System Design: Introduction and concept of productivity, measurement of productivity, productivity measures, productivity measurement models, factors influencing productivity, causes of low productivity, productivity measurement models, productivity improvement techniques, numerical problems on productivity, case study on productivity.

Work Study: Basic concept, steps involved in work study, concept of work content, techniques of work study, human aspects of work study. method study: basic concept, steps involved in method study, recording techniques, operation process charts, operation process charts: examples. flow process charts, flow process charts: examples, two-handed-process charts, multiple activity charts, flow diagrams. string diagrams, principles of motion economy, micro-motion study, therbligs, simo charts memo-motion study, cycle graph and chrono-cycle graph, critical examination techniques, development and selection of new method, installation and maintenance of improved methods.

Work Measurement: Basic concept, techniques of work measurement, steps involved in time study, steps and equipment of time study, performance rating. performance rating: examples, allowances, computation of standard time-i, computation of standard time-ii, case study work sampling: basics, procedure of work sampling study, numerical problems on work sampling, introduction to synthetic data and PMTS, introduction to MTM and MOST

Principles of workplace design, physical requirements in the workplace anthropometrics and communication considerations, social requirements of the workplace- personal and territoriality considerations. Workspace design; general principles, deciding position of control with respect to other controls, position of displays with respect to other displays, positioning of displays and controls, control display compatibility

IK Gujral Punjab Technical University Jalandhar

M.Tech. Mechanical (Manufacturing Engineering and Automation) Batch 2021 onwards

Ergonomics: Ergonomics: Introduction, definition, objectives and scope, man-machine system and its components. Introduction to musculoskeletal system, respiratory and circulatory system, metabolism, measure of physiological functions- workload and energy consumption. Introduction to biomechanics, types of movements of body members, Design of lifting tasks using NIOSH lifting equation, Distal upper extremities risk factors, risk assessment tools; Strain Index, RULA, REBA. Introduction to anthropometry; work table and seat designing. Design of Visual displays and controls. Occupational exposure to; noise, whole body Vibrations, heat stress and dust. Effect of vibration/ noise, temperature, illumination and dust on human health and performance

Recommended Books:

1. Introduction to Work Study: International Labor Office (ILO), Geneva.
2. Motion and Time Study Design and Measurement of Work: Ralph M. Barnes, Wiley, The University of California.
3. Industrial Engineering and Production Management: M. Telsang, S. Chand and Company Ltd.
4. Lakhwinder P S, "Work Study and Ergonomics", Cambridge University Press, 2016.
5. Benjamin E Niebel and Freivalds Andris, "Methods Standards & Work Design", Mc Graw Hill, 1997.

MTME-217 METROLOGY AND INDUSTRIAL INSPECTION

L	T	P
4	0	0

Course Objective

1. To expose the students to various measurement techniques used for the measurement of physical variables in manufacturing industries
2. To expose to various control techniques employed in process automation and develop automation system for manufacturing and process industries.

Course Outcomes

After completing the course students will be able to:

1. Study the characteristics and specification of instruments.
2. Implement various control and automation method in process industries.

DETAILED SYLLABUS

Limits, Tolerance & Gauges – Types of Measurement, Error in Measurement, Limits, Tolerance-Dimensional & Geometrical, Allowance, Types of Fites, Hole and Shaft Basis Measurement, Gauges, Different Types of Limit Gauges, Snap Gauges, Taper Gauges, Ring Gauges. Methods & Measuring Equipments for Testing of Limit Gauges.

Linear, Angular & Circular Measurements - Gauges for the Linear Measurement, Determination of Taper of Ring Gauge by Precision Balls and Rollers, Sign Bar, Clinometers, Autocollimators, Roundness Measurement of Shaft by Dial Indicator Method, Optical Dividing Head.

Measurement – Temperature: Radiation pyrometers and thermal imaging. Pressure: Electro-mechanical and electronic pressure measuring instruments. Low pressure measurement.

Thread and Gear Measurement

Measurement of Major and Minor Diameter of External and Internal threads, Pitch Measurements, Angle and forms of Thread Measurement. Screw Head Gauges- Plug and Ring Gauge, Thread Caliper Gauge.

Measurement of Forms and Pitch of Gear Teeth by Parson's Gear Rolling Tester, Tooth Thickness Measurements- Constant Chord Method and Basic Tangent Method; Testing of Involutes and Cycloidal Form of Gear Teeth, Depth Measurement.

Measurement of Surface Texture

Waviness, Straightness and Roughness Measurement R_a, RMS, R_z, CLA Value; Fatness Measurement, Use of Optical Flats, Surface Plates, Straight Edge, Comparators- Optical, Mechanical, Pneumatic and Electronic.

Industrial Inspection:

Visual Inspection, Online and Offline Inspection, Inspection by variables and by Attributes, Automatic

Gauging, Coordinate Measuring Machine, Non-contact Inspection Methods, Post Process Metrology, Computer Aided Inspection Using Robot, Industrial Inspection Instruments and Their Calibrations.

Recommended Books:

1. Mechanical and Industrial Measurement, R.K. Jain, Khanna Publishers
2. Measurement Systems- Application and Design, Deobelin, E.O, Mc Graw Hill, New York
3. Handbook of Dimensional Measurement, Industrial Press, New York.
4. Engineering Metrology, R.K. Jain, Khanna Publishers.

MTME-218 FINITE ELEMENT ANALYSIS

L	T	P
3	1	0

Course Objective:
The objective of the course is to enable the students to understand the basic concepts of Finite Element Analysis, its methods and application for complex engineering problems.

Course Outcomes:

After completing the course, the students will be able:
CO1: To explain the concepts behind formulation methods in FEM.
CO2: To identify the application and characteristics of FEA elements such as bars, beams, plane and iso-parametric elements.
CO3: To develop element characteristic equation and generation of global equation.
CO4: To apply suitable boundary conditions to a global equation for bars, trusses, beams, circular shafts, heat transfer, fluid flow, axi-symmetric and dynamic problems and solve them for displacements, stress and strains induced.

DETAILED SYLLABUS

Introduction to Finite Element Method
Basic concept, Historical background, engineering applications, general Description, comparison with other methods.

Formulations and Variation Methods
Need for weighted, integral forms, relevant mathematical concepts and formulae, weak formulation of boundary value problems, variational methods, Rayleigh –Ritz method and weighted residual approach.

Finite Element Techniques
Model boundary value problem, finite element discretization, element shapes, sizes And node locations, interpolation functions, derivation of element equations, connectivity, boundary conditions, FEM solution, post-processing, Compatibility and completeness requirements, convergence criteria, higher order and isoparametric elements, natural coordinates, Langrange and Hermit Polynomials.

Applications to Solid and Structural Mechanics Problems
External and internal equilibrium equations, one-dimensional stress-strain relations, plane stress and strain problems, axis symmetric and three dimensional stress-strain problems, strain displacement relations, boundary conditions compatibility equations, analysis of trusses, frames and solids of revolution, computer programs.

Application to Heat Transfer Problem
Variational approach, Galerkin approach, one-dimensional and two-dimensional steady state problems for conduction, convection and radiation, transient problems.

Application to Fluid Mechanics Problems

In viscid incompressible flow, potential function and stream function formulation, incompressible viscous flow, stream function, velocity-pressure and stream function-vorticity formulation, solution of incompressible and compressible fluid film lubrication problems.

Recommended Books:

1. Introductory Finite Element Method by Chandrakant S Desai, Tribikram Kundu
2. The Finite Element Method: Volume 2 by O C Zienkiewicz, R L Taylor
3. Building Better Products With Finite Element Analysis by Vince Adams, Abraham Askenazi
4. Finite Element Implementation by Y K Cheung
5. Finite Element Analysis With Personal Computers by Champion, J M Ensminger, Edward R Champion
6. Programming the Finite Element Method by Ian M. Smith, Vaughan Griffiths
7. The Finite Element Method for Engineers by Kenneth H. Huebner, Donald L. Dewhirst, Douglas E. Smith, Ted G. Byrom
8. The Finite Element Method and Its Reliability by Ivo Babuska, T Strouboulis

MTME-219 LOW COST AUTOMATION

L	T	P
3	1	0

Course Objective

1. To give basic knowledge about automation.
2. To understand the basic hydraulics and pneumatics systems for automation.
3. To understand the assembly automation.

Course Outcomes

After completing the course students will be able to:
CO1 Understand the types of automation and its various elements.
CO2 Select various components for low-cost automation systems.
CO3 Do some assembly automation

DETAILED SYLLABUS

Automation of Assembly Lines

Concept of automation - mechanization and automation - Concept of automation in industry - mechanization and automation - classification, balancing of assembly line using available algorithms - Transfer line-monitoring system (TLMS) using Line Status - Line efficiency - Buffer stock Simulation in assembly line.

Automation using Hydraulic Systems:

Design aspects of various elements of hydraulic systems such as pumps, valves, filters, reservoirs, accumulators, actuators, intensifiers etc. - Selection of hydraulic fluid, practical case studied on hydraulic circuit design and performance analysis - Servo valves, electro hydraulic valves, proportional valves and their applications.

Automation using Pneumatic Systems:

Pneumatic fundamentals - control elements, position and pressure sensing -logic circuits - switching circuits - fringe conditions modules and these integration - sequential circuits - cascade methods - mapping methods – step counter method - compound circuit design - combination circuit design. Pneumatic equipment's - selection of components - design calculations -application - fault finding – hydro pneumatic circuits - use of microprocessors for sequencing - PLC, Low cost automation - Robotic circuits.

Automation using Electronic Systems

Introduction - various sensors – transducers - signal processing - servo systems - programming of microprocessors using 8085 instructions - programmable logic controllers

Assembly Automation

Types and configurations - Parts delivery at workstations - Various vibratory and non-vibratory devices for feeding - hopper feeders, rotary disc feeder, centrifugal and orientation - Product design for automated assembly.

Recommended Books:

1. Anthony Esposito, "Fluid Power with applications", Prentice Hall international, 2009.

2. Mikell P Groover, "Automation, Production System and Computer Integrated Manufacturing", Prentice Hall Publications, 2007.
3. Kuo. B.C, "Automatic control systems", Prentice Hall India, New Delhi, 2007.
4. Peter Rohner, "Industrial hydraulic control", Wiley Edition, 1995.
5. Mujumdar.S.R, "Pneumatic System", Tata McGraw Hill 2006.

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY

Estd. Under Punjab Technical University Act, 1996
(Punjab Act No. 1 of 1997)

Ref. No. : IKGPTU/Reg/N/ *Dated :*

NOTIFICATION

Sub: **Regarding Pre-Ph.D Course work.**

This is for information of all concerned that Pre-Ph.D course work from 2016-17 will be conducted in the IKGPTU main campus Kapurthala in regular mode. The PhD course work will consists of minimum 15 credits. The structure of the course work is as under.

Sr. No.	Nature of course	Name of course	Credits	Remarks
1.	Core	1.Research Methodology	4	The syllabus of RM should be formulated faculty wise such as Engineering, Science, Management/ Humanities and Life sciences
		2.Subject related theory paper	4	Discipline specific related to advancements in theoretical methods for research
		3. Presentation	3	Discipline specific
2.	Interdisciplinary	4. Elective	4	From list of subjects from allied fields
	Total Minimum credits		**15**	

-Sd-
Registrar

Endorsement No: IKGPTU/REG/N/ 6244-4251 Dated: 22.08.2016

1. Secretary to Vice Chancellor: For kind information of Vice Chancellor
2. Dean (P&D)
3. Dean (RIC)
4. Dean (Academics)
5. Finance Officer
6. Controller of Examination
7. DR (Computers): For uploading on website
8. File Copy

Registrar 22/8/16

I. K. Gujral Punjab Technical University, Jalandhar
Jalandhar Kapurthala Highway, Near Pushpa Gujral Science City, Kapurthala - 144 603
Ph. No. 01822 - 662521, 662501 Fax No. : 01822-255506, 662526. Email : registrar@ptu.ac.in

M.E

Pre Ph.D. Course in Mechanical Engineering
Schematic and Syllabus

Sr. No.	Nature of Course	Name of course	Credits	Remarks
1.	Core	Research Methodology	4	The syllabus of RM should be formulated faculty wise
		Discipline Specific subjects	4	1. Advanced Heat Transfer 2. Non-Conventional Machining 3. Advanced Fluid Mechanics and CFD 4. Finite Elements Methods 5. Composite Materials 6. Optimization Techniques 7. Computer Aided Design 8. Advanced Theory of Vibrations 9. Tribology 10. Thermo Economics and Power Plants 11. Advanced Thermodynamics
		Presentation	3	Discipline specific
2.	Interdisciplinary	Elective	4	From list of subjects from allied fields 1. Production Engineering 2. Advanced Mechanics of Solids 3. Mechatronics 4. Product Design and Development 5. Material Handling Equipment Design
	Total Minimum credits		**15**	

(Prof. B.S. Pabla) (Prof. A. Manna)

Head
Department of Mechanical Engineering
I.K. Gujral Punjab Technical University
(Main Campus Kapurthala)

Pre Ph.D. Course in Mechanical Engineering

Research Methodology

L	T	P
4	0	0

Research Scholar will have to present a seminar based upon his/her research area. Performance of the scholar and participation in seminar will be taken into consideration.

1. Introduction to Research Methodology: Definition, Need, Concept, Types, Uses, Research techniques, Reviewing literature: Need, Sources-primary and secondary, Purposes of review, Scope of review, Steps in conducting review.

2. Identifying and defining research problem: Locating, analyzing, stating and evaluating problem, generating different types of hypotheses and evaluating them.

3. Review of data collection: Static and dynamic characteristics of instruments used in experimental set up, calibration of various instruments, sampling methods, methods of data collection, selection of appropriate method for data collection, data collection using a digital computer system, case studies of data collection.

4. Data Analysis: Data processing, data analysis strategies and tools, data analysis with statistical packages, basic concepts concerning testing of hypotheses, procedures of hypothesis testing, generalization and interpretation applied statistics: regression analysis, parameter estimation, multivariate statistics, principal component analysis software tools for modeling, simulation and analysis.

5. Design of Experiments: Concept design, Parameter design, Tolerance design, Quality loss function, Signal-to- Noise ratio, Orthogonal array experiments, Analysis of Mean (ANOM), Quality characteristics, Selection and testing of noise factors, Selection of control factors, Parameter optimization experiment, Parameter design case study

6. Analysis of Variance: Introduction, Example of ANOVA process, Degrees of freedom, Error variance and pooling, Error variance and application, Error variance and utilizing empty columns, the F-test, case study and practical applications.

7. Research reports and Thesis writing: Structure and components of scientific reports, types of report, developing research proposal. Thesis writing. Procedure and steps.

8. Research ethics, IPR and publishing Ethics: ethical issues. IPR: intellectual property rights and patent law, techniques of writing a Patent, filing procedure, technology transfer, copy right, royalty, trade related aspects of intellectual property rights Publishing: design of research paper, citation and acknowledgement, plagiarism tools, reproducibility and accountability.

Books:

1. C.R. Kothari, "Research Methodology-Methods and Techniques", Wiley Eastern Ltd 2009.
2. B.L. Wadehra, Law relating to patents, trademarks, copyright designs and geographical indications, Universal Law Publishing, 2014.
3. K. N. Krishnaswamy, Appa Iyer Sivakumar, M. Mathirajan," Management Research Methodology: Integration of Methods and Techniques, Pearson, 2006 4. S.P Gupta,"Statistical Methods", Sultan Chand & Sons, 2006.
4. Douglas C Montgomery, "Design and Analysis of Experiments" ,John Wiley Publishers.
5. Montgomery D.C., Runger G.C., "Introduction to Linear Regression Analysis", John Wiley Publishers.
6. Myres R.H. and Montgomery D.C., "Response Surface Methodology Process and Product Optimization using designed experiments", Wiley Publishers.

Pre Ph.D. Course in Mechanical Engineering
Advanced Heat Transfer

L	T	P
4	0	0

1. Conduction: Steady state heat conduction including heat generation and heat losses in different co-ordinates, numerical analogue and graphical methods. Unsteady state heat conduction as applied to thick wall, cylinder and sphere with sudden and with periodic changes of surface temperature. Semi-infinite state with imposed wall temperature distribution. Heat conduction with moving boundaries, numerical analogue and graphical methods.

2. Conductive Heat Transfer: Fundamentals: Reynold transport theorem. Derivation of N.S equation and energy; Dimensionless Number. Numerical problems and mathematical modelling.

3. Convection: Convection in fully developed flow and developing flow. Effect of wall boundary condition. Natural Convection: External flows, boundary laying integral similarity solution; Exact & empirical correlation, Heat transfer over plane plate, cylinders, tube banks,

channel and spheres. Turbulent Flows: Fundamental of Turbulent Heat convection: turbulent boundary layer; Exact & empirical correlations. Numerical problems and mathematical modelling.

4. Radiation: Law of Radiation, shape factor Algebra, Radiative heat exchange between different surfaces of simple geometric shape. Use of electrical analogy in solving problem of Radiative heat exchange. Combined effect of heat transfer due to conduction, convection and radiation, use of relaxation methods.

5. Case studies, formulation of problems, Mathematical modelling and simulation.

Books:

1. Incropera & Dewtt," Heat & Mass Transfer", John Willey Ltd.
2. J.P. Holman," Heat Transfer", TMH
3. R.C. Sachdeva," Heat & Mass Transfer", New Age
4. Heat Transfer by P.K. Nag

Pre Ph.D. Course in Mechanical Engineering
Non Conventional Machining

L	T	P
4	0	0

1. Introduction: Classification, Advantages & limitations of non conventional machining, Hybrid Machining, Ultrasonic machining (USM)-Principle of operation, process details, applications and advantages, limitations of USM.

2. Abrasive and Water Jet Machining: Basic principle, mechanism of material removal, working principle of Abrasive jet machining (AJM), water jet machining (WJM), merits & demerits, application. Chemical Machining (CM): Working principle, process characteristics, procedures, advantages & disadvantages of chemical machining. Process parameters, their effects on machining characteristics.

3. Electrochemical Processes: Fundamentals, ECG, Electrochemical deburring etc, details of machining setup, materials and selection of tools, Process parameters, their effects on machining characteristics; applications.

4.Thermal Metal Removal Processes: Working principles, Mechanism of material removal, process parameters, advantages & limitations, applications of processes like electric discharge machining(EDM), Electron Beam Machining (EBM), Ion beam machining (IBM), Plasma arc machining (PAM), Laser beam machining(LBM). Process parameters and their effects on machining characteristics.

Books:

1. V K Jain, "Advanced Machining Processes," Allied Publishers, 2009.
2. G.F. Benedict, "Unconventional Machining Methods", McGraw-Hill.
3. HMT, "Production Technology," Tata McGraw-Hill, 2001.
4. M. Adithan," Non Convectional Machining," John Wiley.
5. P.K. Mishra," Non Conventional Machining", Narosa Publishers.
6. Shan & Pandey," Modern machining process", Tata McGraw-Hill.

Pre Ph.D. Course in Mechanical Engineering
Advanced Fluid Mechanics and CFD

L	T	P
4	0	0

1. Introduction: The continuity equation, Stream function, sources and sink, flow field due to source and sink.

2. Tensors: Indicial Notation, Tensors, Tensor Calculus, Curvilinear Coordinates, doublet, two dimensional flow past solid bodies, and vortex potential, Velocity functions. Application of tensors in fluid flow and analysis.

3. Kinematics of a Continuum, Stress, Integral Formulation of General Principles, Limiting cases of small viscosity, exact solution, theory of hydrodynamic lubrication, Flow analysis and simulation.

4. The Elastic Solid: Linear Isotropic Solid, Linear Anisotropic Elastic Solid, Constitutive Equation for Isotropic Solid under Large Deformation, Case study and analysis.

5. Newtonian Viscous Fluid and Non-Newtonian Fluids: Linear and Non-Linear Viscoelastic Fluid. Viscometric Flow of Fluids under various conditions.

6. Computational Fluid Dynamics: Dimensionless equations; Simplified mathematical models; Hyperbolic, Parabolic & Elliptic systems, Properties of numerical solutions (Consistency,

Stability, Conservation, Convergence and Accuracy) Heat and Mass transfer Problems formulation and analysis, Multi Phase Flows analysis and simulation.

Books:

1. J. K. Vennard and Robert L. Street: Elementary fluid mechanics.
2. John D Anderson,: Computational Fluid Dynamics, Mcgraw Hill.
3. T. J. Chung ,Computational Fluid Dynamics, Cambridge University Press.
4. H.Versteeg and W. Malalasekra,: An Introduction to Computational Fluid Dynamics". Pearson
5. Niyogi Pradip, Chakraborty S K and Laha M K: Introduction to Computational Fluid Dynamics". Pearson

Pre Ph.D. Course in Mechanical Engineering
Finite Element Methods

L	T	P
4	0	0

1. FEM: Introduction and concept, Stresses and equilibrium, Boundary Conditions, Strain-Displacement Relations, Stress-Strain Relations, Temperature Effects, Vectors and Matrices, Classification of Differential Equations, Rayleigh-Ritz Method, Galerkin's Method, Point Collocation Method, Least Square Method, Weighted Residual Method, Variational Formulation.

2. 1-D FE Modeling: Finite Element Modeling, Coordinates and Shape Functions, Generalized Coordinates, Natural Coordinates in 1D, 2D and 3D, Coordinate Transformation, Assembly of Global Stiffness matrix and Load vector, Properties of Stiffness Matrix, Treatment of Boundary Conditions and Temperature Effects. Truss and Beam problems formulation and analysis.

3. 2-D FE Modeling: Finite Element Modeling, Constant Strain Triangle (CST), Case study and analysis, 3-D FE Modeling: The Four Node Quadrilateral, Numerical Integration, Higher Order Elements: Nine Node Quadrilateral, Eight Node Quadrilaterals, Six Node Triangle , Truss: Introduction, Plane Trusses, Assembly of Global Stiffness Matrix, Load and displacement vectors, Case study in 3-D analysis.

4. Higher-Order Elements: Plate Bending, C0 and C1 Elements, Non-conforming Elements and Patch Test, Scalar Field Problems: Introduction, Steady-state heat transfer, Potential Flow, Fluid Flow in Ducts, Problems and solutions.

5. Testing and characterization: Different tests like internal stress measurement by diffraction, metallographic preparation etc with special emphasis to metal matrix composites, XRD, SEM analysis, Mechanical and Physical properties analysis.

6. Secondary processing and application of composites: Secondary processing like machining, joining and forming of composites; Application and case studies.

Books:

1. S.C. Sharma, "Composite Materials", Narosa Publishers.
2. R.K. Everret & R.J. Arsenault, "Metal matrix composites", Academic press.
3. T.W. Cline , P.J.Withers, Introduction to metal Matrix Composites, Csambrodge University Press

Pre Ph.D. Course in Mechanical Engineering
Optimization Techniques

L	T	P
4	0	0

1. Introduction to Optimization: Introduction and Engineering applications of optimization, Optimal Problem Formulation; Design-variables, Constraints, Objective function, Variable bounds.

2. Numerical Techniques: Introduction to numerical techniques, Numerical differentiation and numerical integration, Eigen value problems, Newton-Raphson's method, Computer based numerical analysis.

3. Single-variable Optimization: Optimality Criteria, Bracketing Methods – Exhaustive search and Bounding phase methods, Region-Elimination Methods-Interval halving method; Fibonacci search method, golden section search method, Point-Estimation Method: Successive quadratic estimation method, Gradient-based Methods: Newton-Raphson method, Bisection method, Secant method, Cubic search method.

4. Multivariable Optimization: Optimality Criteria, Unidirectional Search, Direct Search Methods: Simplex, Hooke-Jeeves pattern search and Powell's conjugate direction method, Gradient-based Methods: Cauchy's (steepest descent) method, Newton's method, conjugate gradient method, variable-metric method.

5. Constrained Optimization: Kuhn-Tucker Conditions. Transformation Methods: Penalty function method, Sensitivity Analysis. Direct Search for Constrained Minimization: Variable elimination, Complex search and Random search methods, Linearized Search Techniques: Frank-Wolfe method, Cutting plane method, Feasible Direction Method, Generalized Reduced Gradient Method, Gradient Projection Method. Integer Programming. Geometric Programming.

6. Evolutionary Techniques: Introduction to Fuzzy Logic, Neural networks, RSM, GA, Ant Colony, Techniques.

Books:

1. Sastry S.S., "Introductory methods of Numerical Analysis", Prentice Hall India, 2009.
2. Rao S.S., "Engineering Optimization: Theory and Practices", John Wiley and Sons, 4th Edition, 2009.
3. Kambo N.S., "Mathematical Programming Techniques" East West Press, 2009.
4. Deb Kalyanmoy, "Optimization for Engineering Design: Algorithms and Examples", Prentice Hall of India New Delhi, 2005.

Pre Ph.D. Course in Mechanical Engineering
Computer Aided Design & Manufacturing (CAD/CAM)

L	T	P
4	0	0

1. Introduction: Types of models, Construction of solid models. Wire frame Models, surface modeling. Wire frame Entities, Curve Representation. Parametric Representation of Analytic Curves - Review of Vector Algebra, Lines, Circles, Ellipses, Parabolas, Hyperbolas, Conics.

2. Parametric Representation of Synthetic Curves - Hermite Cubic Splines, Bezier Curves, B-Spline Curves, constrain and applications

3. Computer Aided Manufacturing (CAM): Introduction and Definition of Computer Aided Manufacturing, Introduction to Numerical Control, CNC machines, Direct Numerical Control Part Programming, Introduction to Robotics, Computer Integrated Manufacturing Elements of CIM, CIM wheel, Benefits of CIM, Concepts of FMS, Automatic Storage and Retrieval System (AS/RS), Automated Guided Vehicles (AGVs Group Technology(GT), Computer Aided Process Planning (CAPP), Co-Ordinate Measuring Machine (CMM). Rapid Prototyping, Role of RPT, Design of CIM system for specific applications.

4. Finite Element Analysis: Calculus of variation, Introduction to equilibrium equations in elasticity, Euler's Lagrange's equations, FEM Procedure, Derivation of FEM equations by variation principle polynomials, Concept of shape functions, Weighted residual Methods, Galerkin's method, Solving truss and beam problems by Galerkin's approach, Derivation of shape functions for CST triangular elements, rectangular elements, quadrilateral elements etc.

5. Higher order Elements: Concept of iso-parametric elements, Concept of sub-parametric and super -parametric elements, Concept of Jacobin matrix. Numerical Integration. Automatic mesh generation schemes. Convergence criteria. Compatibility requirements. Geometric isotropy invariance.

Books:

1. Ibrahim Zeid, "CAD/CAM-theory and practice", McGraw-Hill, New York, 1991.
2. M.P. Groover, E.W. Zimmer, " CAD/CAM-Computer-Aided Deasign & Manufacturing", Pearson Education India, 1984.
3. P.N. Rao, "CAD/CAM: Principles & Applications", Tata McGraw-Hill Education Private Limited, New Delhi, 2010.

Pre Ph.D. Course in Mechanical Engineering
Advanced Theory of Vibrations

L	T	P
4	0	0

1. Fundamentals of Vibration: Review of free and forced vibrations, Single and Two degree freedom systems subjected to Forced and Motion Excitation. Response to arbitrary periodic and aperiodic excitations.Impulse response - Transient vibration - Laplace transformation formulation. Fourier transforms- definition, Relation to transfer functions, First order systems, applications. Basic Concepts like Passive, Semi-active and Active Parameters.

2. Two Degree Freedom System: Optimum design of single, two degree of freedom systems, Vibration Absorber and Vibration isolators. Case study and analysis.

3. Multi Degree Freedom System : Normal mode of vibration - Flexibility matrix and stiffness matrix - Eigen value and Eigen vector – Orthogonal properties - Modal matrix - Modal analysis - Forced vibration by matrix inversion - Modal damping in forced vibration - Numerical methods of determining natural frequencies.

4. Vibration of Continuous Systems: Systems governed by wave equations - Vibration of strings - Vibration of rods - Euler's equation for beams - Effect of Rotary inertia and shear deformation - Vibration of plates.

5. Experimental Methods in Vibration Analysis: Vibration instruments - Vibration exciters, Measuring Devices - Analysis - Vibration Tests - Free and Forced Vibration tests. Collection of FRF, Experimental modal analysis methods, Examples of vibration tests - Industrial case studies and analysis.

6. Dynamic Analysis: Dynamic analysis - Equation of motions - Mass matrices - Free vibration analysis - Natural frequencies of Longitudinal - Transverse and torsional vibrations - Introduction to transient field problems and solution.

7. Validation of Analytical Models: Preliminary check, Parameter setting, Correlation of analytical model with experimental model, Model updating- fundamentals.

8. Non-Linear Vibrations: Introduction, Sources of nonlinearity, Qualitative analysis of nonlinear systems, Phase plane, Conservative systems, Stability of equilibrium, Limit cycles-van der pol oscillator, Perturbation method, Chaos, Method of iteration, Selfexcited oscillations, Lindstedt's Method. Applications of various methods and formulation of problems.

Books:

1. Thomson W.T., "Theory of Vibration with Applications" CBS Publishers and Distributors, New Delhi, 1990.

2. Den Hartog J.P., "Mechanical Vibrations", Dover Publications, 1990.

3. Rao S.S., "Mechanical Vibrations", Addison Wesley Longman, 1995.

Pre Ph.D. Course in Mechanical Engineering
Tribology

L	T	P
4	0	0

1. Introduction: Definition, General considerations in the design of gears, Cams, Reciprocating components, etc. Engine Tribology basics- Tribology aspects of engine components such as bearings, piston assembly, valve train and drive train etc.

2. Friction and wear: Nature of friction, surface properties, surface characteristics and measurements. Friction: sliding, static characteristics of common metals and non-metals,

analysis under extreme environments. Wear: type of wear, wear mechanism, factors affecting wear, selection of materials for different wear situations, measurement of wear, tribometers and Tribometry, Engine wear-mechanisms, Wear resistance materials and coatings, failure mode analysis, Case study and analysis.

3. Lubrication and Lubricants: Theory of hydrodynamic lubrication, Reynolds Equation, Slider bearings, Fixed and pivoted shoe bearings, Hydrodynamic journal bearings, short and finite bearing, Thrust bearings, Sintered Bearing, Non Circular and circular bearings, single and multi side surface bearings. Lubrication: type of lubricants, Properties and Testing, Classification of lubricants, Lubrication of tribological components: Lubrication systems, Lubricant monitoring, SOAP, Ferrography and other rapid testing methods for lubricants contamination. Processes for removal of contamination and analysis the effect of lubricants on performance.

4. Hydrostatic (externally-pressurized) & Elasto-Hydrodynamic lubrication: Hydrostatic bearing-basic concepts, bearing pad coefficient, Restrictors-Capillary, Orifice and flow control valve-bearing characteristic number and performance coefficients for Flat, Conical and Spherical pad thrust bearings, Multirecess journal and thrust bearings, Air and gas lubricated bearings, Lubrication of Ball and roller bearings, cams and gears, Selection and life estimation, Fatigue and diagnostics, Case study.

Books:

1. Bowden F.P. & Tabor D., "Friction and Lubrication of solids", Oxford University Press., 1986.

2. Ernest Rabinoweiez: "Friction and Wear of materials" Interscience Publishers, 1995.

3. Neale M.J., Tribology-: Hand Book", Butterworth, 1995.

4. Fuller D.D.: "Theory and practice of Lubrication for engineers", John Wiley sons, 1984.

5. Gross W. A.: "Gas film lubrication", Wiley, 1980.

Pre Ph.D. Course in Mechanical Engineering
Thermo economics and Power Plants

L	T	P
4	0	0

1. Thermodynamics laws, Concept of various energy sources, Energy analysis, Availability, Laws of optimization of thermal systems.

2. Energy audits and conservation programme, elements of energy accounting. Load estimation, balancing and justification.

3. Economic aspects of Power plants. Economic analysis- principles of the economic evaluation, levelized cost.

4. Thermo- economic analysis: Fundamentals of thermo- economics, thermo- economic variables, thermo- economic evaluation, thermo- economic optimization.

5. Review of various thermodynamic cycles, Thermodynamic optimization of design parameters. Real cycle effects- internal and external irreversibilities, pressure drops, heat loss, combustion losses and their impact on thermodynamic cycle.

6. Coal based power plants, Performance analysis of components, steam power plants heat balance. Nuclear power plant and performance analysis. Solar energy and power plant analysis.

Books:

1. Thermal Design & Optimization by Bejan.
2. Energy method of Thermal Plant analysis by Kotas.
3. Power Plant engineering by P.C. Sharma

Pre Ph.D. Course in Mechanical Engineering

Advanced Thermodynamics

L	T	P
4	0	0

1. Introduction: Review of laws of thermodynamics, Available and unavailable energy, availability of the closed system and steady flow stream; irreversibility; effectiveness, Various thermodynamic laws applicable to power plant and refrigeration cycles.

2. Real Gases and Mixtures: Behaviour of real gas, Derivation of real gas from ideal gas, equations of state; generalized compressibility chart; property deviations for real gases. Dalton's law; pseudo-critical temperature and pressure; Kay's rule and applications.

3. Chemical Equilibrium and the Third Law Chemical potential; phase equilibrium; phase rule without chemical reaction; chemical potential of ideal gases; fugacity, evaluation of fugacity of mixtures; fugacity of solids and liquids; ideal solutions. Dead state condition and analysis.

4. Rault's and Henry's laws; equilibrium constants; third law; Δ W, ΔG and ΔS of reaction, reaction; reversible cell; Gibbs-Helmholtz equation. Kinetic Theory of Gases Equation of state of an ideal gas; distribution of molecular velocities; energy distribution function; principle of equi-partition of energy; classical theory of specific heat capacity; mean free path, distribution of free paths; coefficient of viscosity; thermal conductivity; mass diffusivity, their importance and applications.

Books :

1. Kenneth Wark, "Advanced Thermodynamics For Engineers", McGraw-Hill, 1995.
2. Andrian Bejan, "Advanced Engineering Thermodynamics", John Wiley & Sons. New York, 1988.
3. Francis Weston Sears, "An Introduction to Thermodynamics: The Kinetic Theory of gases and Statistical Mechanics", Addison-Wesley Publishing Company, 1953.
4. Rowland S. Benson, "Advanced Engineering Thermodynamics", Pergamom Press, 1977.
5. Richard E. Sonntag & Gordon J. Van Wylen, "Introduction to Thermodynamics: Classical & Statistical", John Wiley & Sons, 1991.

Pre Ph.D. Course in Mechanical Engineering (Interdisciplinary Course)

Production Engineering

L	T	P
4	0	0

1. Manufacturing Processes: Review of basic processes, analysis of progressive solidification, heat transfer in casting and Fusion Welding. Study and effect of various parameters. Conventional and Non Conventional Machining Processes, Study of procedural steps for formation of mathematical relation to correlate the input parameters and output performance, Material Forming processes, Powder metallurgy . Hybrid electro-chemical processes, Hybrid thermal processes, Solid, liquid and powder based material addition processes.

2. Metrology and Quality Control: Importance and principle, Measuring equipment and purpose. Error due to Numerical Interpolation, displacement measurement technique, Error types and their evaluation, Image processing and its applications in metrology, Laser trackers, micro and nanometrology.

3. Process capability: Process Capability Index. Advanced dimensional chain and tolerance stacking , Global management, six sigma management, applications.

4. Methods of improving surface integrity, Quality Control, Statistical Qaality Control, Quality assurance systems. Study the procedural steps for formation of mathematical model to correlate the input parameters and output performance.

Books:

1. Serope Kalpakjian , Manufacturing Engineering and Technology.
2. R. K. Jain, Production Technology: Manufacturing Processes, Technology and Automation
3. A.K.Chitale, R.C.Gupta: Production and manufacturing, Prentice hall of India

Pre Ph.D. Course in Mechanical Engineering (Interdisciplinary Course)

Advanced Mechanics of Solids

L	T	P
4	0	0

1. Stress and strain: Review stress strain relationships for various materials, Equations of equilibrium, Boundary conditions, Compatibility, Stress functions and Biharmonic equation. Two dimensional problems in Rectangular coordinates, Applications to polynomials in rectangular coordinates, Failure: Theories of failure, Mohr's theory of failure, Ideally plastic solid, Yield surfaces of Tresca and Von Mises, Stress-Strain relations, Plastic flow, Prandtl-Reuss equations, Saint Venant-Von Mises equations.

2. Two dimensional problems in polar coordinates: General equations in polar coordinates, Pure bending of curved bars, Strain components in polar coordinates, Rotating discs, stresses in a circular discs.

3. Shear center: Shear stress, distribution and shear centre for thin walled open sections. Bending of Beams, Energy Methods: Introduction to elastic stability, Plasticity, Work done by forces and elastic strain energy stored, Reciprocal relation, Maxwell-Betti-Rayleigh reciprocal theorem, Begg's Deformeter, First theorem of Castigliano, Expressions for strain energy, Theorem of virtual work, Kirchhof's theorem, Second theorem of Castigliano or Menabrea's theorem, Generalisation of Castigliano's theorem or Engesser's, Maxwell-Mohr Integrals.

4. Torsion: Torsion of bars with elliptical square and rectangular cross section, Membrane analogy, Hydro dynamical analogy, Torsion of Solid shafts, hollow and thin tubes.

5. Membrane stresses in shell and storage vessels, Shells and vessels of uniform strength.

6. Contact stresses: Problem of determining contact stresses, Assumption Expressions for principal stresses, Numerical problems and solution.

Books:

1. S. Timoshenko and J.W. Goodier, "Theory of Elasticity" MGH book co Ltd.
2. J.P. Den Hartog, "Advanced strength of materials" MGH book co Ltd.
3. F.B. Seety & Smith "Advanced mechanics of materials" John Wiley & Sons.
4. Irving H. Shames & James M. Pitarresi, "Introduction to Solid Mechanics", 3rd ed, PHI, pub.
5. Boresi A.P. and Sidebottom O.M., "Advanced Mechanics of Materials", John Wiley,

Pre Ph.D. Course in Mechanical Engineering (Interdisciplinary Course)

Mechatronics

L	T	P
4	0	0

1. Introduction: Definition, review of basic electrical, mechanical and mechatronics Systems, Measurement and Control Systems, Microprocessor- based controllers, Mechatronics Approach.

2. Sensors and transducers: Classification, Performance Terminology, Displacement, Position & Proximity Sensors, Velocity & Motion, Force, Fluid Pressure, Liquid Flow, Liquid Level, Temperature & Light Sensors, Selection of Sensors, Transducers and their applications.

3. Electronic fundamentals: Signal Conditioning Process, Operational Amplifier, Digital Logic, Logic Gates, Boolean Algebra, Data Acquisition Systems, Measurement Systems, Testing and Calibration.

4. Actuators: Mechanical Actuation Systems, Hydraulic & Pneumatic Actuation Systems, Electrical Actuation Systems, A.C. Motor, D.C. Motor, Stepper Motor.

5. System modelling & control: Mathematical Models of Engineering Systems, Electromechanical & Hydro-mechanical Systems, Modelling of Dynamic Systems, Transfer Functions, Introduction to MATLAB & SIMULINK, Control Modes, PID and other Controllers. Their functions and applications.

6. Microprocessor & computer: Interfacing of computer with electromechanical system, Microcomputer Structure, Microcontrollers, Application of Microcontrollers, PLC and their applications.

7. Mechatronics System Design: Steps in designing of Mechatronics system, Possible Design Solutions, Case Studies and analysis.

Books:

1. Mechatronics, W. Bolton, Pearson Education Asia.
2. Mechatronics, Dan Necsulescu, Pearson Education Asia.
3. Measurement Systems, E.O. Doeblin, McGraw Hill.

Pre Ph.D. Course in Mechanical Engineering (Interdisciplinary Course)

Product Design and Development

L	T	P
4	0	0

1. Introduction to product design: Basic design considerations, Role of Aesthetics in product design, Functional design practice, Approach industrial product based on idea generation and innovativeness to meet the needs of the developing society, Design and development process of industrial products, Various steps such as creative process involved in idea of marketing, Designer: role, myth and reality, Use of modelling technique, prototype designs, conceptual design and applications.

2. Design for Production: Design of machine components, forging design, pressed component design, casting design, eliminating defects, Design for machining work holding and clamping devices, Design of powder metallurgical parts.

3. Industrial Product Design: General design situations, specifications, requirements and ratings, their importance in design, market requirements and manufacturing aspects of industrial designs. Aspects of ergonomic design of machine tools, testing equipments, instruments, automobiles, process equipments etc.:Style, form and color conventions in

industrial design, Design of Consumer Product, Specification, requirements and rating of their importance in design, functions and use, standard and legal requirements, body/dimensions. Ergonomic considerations, interpretation of information, conversions for style, forms, colors etc.

4. Economics Considerations: Selection of material, Design for production, Use of standardization, Value analysis and cost reduction. Maintenance aspects of product design. Economic Factors Influencing Design: Product value, Design for safety, Reliability and Environmental considerations, Manufacturing operations in relation to design, Economic analysis, Profit and competitiveness, Break even analysis, Economics of a new product design. Case studies and applications.

5. Value Engineering and Product Design: Introduction, Historical perspective, Value, Nature and measurement of value, Maximum value, Normal degree of value, Importance of value, Analysis Job Plan, Creativity, Steps to solve the problems and value analysis, Value Engg. Idea generation check list, Cost reduction, Materials and process selection in value engineering.

6. Design Organization : Organization structure, Designers position, Drawing office procedure, Standardization, Record keeping, Legal product of design patents. Term Work: Minimum Ten assignments based on above topics.

Books:

1. Product Design and Development by Kail T Ulrich and Steven D Eppinger.
2. Product Design and Development by A.K. Chitale and Gupta.
3. Design of Systems and Devices by Middendorf Marcel Dekker.
4. Problems of product design and development – Hearn Buck, Pergamon Press.

5. Dynamic Considerations: Element Mass Matrices, Evaluation of Eigen Values and Eigen Vectors, Applications.

6. CAFEM: Introduction, Computer Program for formation of System Matrices, Knowledge about different software used in solving of FEM problems.

Books:

1. Chandrupatla and Belegundu, "Introduction to Finite Elements in Engineering", PHI.
2. Bathe, "Finite Element Procedures," PHI.
3. Reddy, "An Introduction to Finite Element Method," TMH.
4. Huebner, "The Finite Element Methods for Engineers," John Wiley.
5. Zienkiewicz, "The Finite Element Method", TMH.
6. Buchanan, "Finite Element Analysis", McGraw-Hill

Pre Ph.D. Course in Mechanical Engineering
Composite Materials

L	T	P
4	0	0

1. Introduction: General introduction to composites; concept of matrix and reinforcements, Characteristics and properties of matrix and reinforcements.

2. Matrix and reinforcement: Types of matrix and reinforcement, volume fraction and weight fraction, Fiber architecture, fiber packing and arrangements, Types of reinforcements, their advantages and limitations.

3. Fabrication methods of polymer composites: Liquid resin impregnated routes, pressurized consolidation of resin pre-pegs, consolidation of resin molding compounds, injection molding of thermoplastics, hot press molding of thermoplastics

4. Fabrication of ceramic and metal matrix composites: Powder based routes, reactive processing, layered ceramic composites, and carbon/carbon composites, Fabrication routes of metal matrix composites: Squeeze infiltration, stir casting, spray deposition, powder blending and consolidation, diffusion bonding of foils, PVD, CVD, Study on experimental set up and process parameters, effects of parameters on performance of fabricated composites.