M.E. 3.1 ENGINEERING MATHEMATICS

Course Objectives: To equip students with adequate knowledge of mathematics that will enable them in formulating problems and solving problems analytically.

Instructional Objective: The course will enable students in handling linear systems using matrices. Use tools like Laplace transforms, Fourier transforms and Fourier series in formulating and solving problems.

No of Lectures per week : 3 hours
No. of tutorials per week : 1 hour
Duration of theory examination : 3 hours
Max. Marks for theory paper : 100
Max. Marks for sessionals : 25
Total Marks : 125
Total no. of modules : 4
No of questions from each module : 2
Total No. of questions to be answered : 5 (at least one question from each module)

MODULE – 1 **(11)**

Matrices : Types of matrices, Determinant inverse of matrix, Elementary transformations, Elementary matrices, Rank of matrix, Reduction to normal form, Canonical form, Rank using elementary transformation, Linear independence and dependence of vectors, System of the form AX = 0, and AX = B, and their solutions, Eigen values, Eigen vectors with properties, Cayley-Hamilton theorem with its applications, minimal polynomial, Diagonazation.

MODULE – 2 **(11)**

Fourier Series : Periodic functions, Trignometric series, Euler's formulae, Drichlet's condition, Even and odd functions, Half range series, Parseval's identity.
Fourier Transformations: Fourier transform, inverse Fourier transforms, applications, convolution theorem.

MODULE – 3 **(11)**

Laplace Transforms: Definition. Existence conditions, properties, inverse Laplace transforms. Laplace transform of periodic functions, Convolution theorem, Laplace transform of Dirac-Delta function, Application of Laplace transforms in solving linear differential equations with initial conditions and system of linear simultaneous differential equations.

MODULE – 4 **(12)**

Partial Differential Equations : Classification of partial differential equation, solution of Partial differential equation by method of separation of variables.
Wave Equation: Derivation and solution of one dimensional wave equation using separation of variable method.

Heat Equation: Derivation and solution of one-dimensional wave equation using separation of variable method.

Text

1. Grewal B. S., Higher Engineering Mathematics, Khanna Publications, New Delhi.
2. Veerarajan, Engineering Mathematics, Tata McGraw Hill Publications.

References

1. Erwin Kreyzing, Advanced Engineering Mathematic, New International Limited.
2. Kandasamy, P. Engineering Mathematics, Chand & Co., New Delhi.
3. Baphana, R. M., Applied Mathematics III, Technova Publication.

M.E 3.2 MACHINE DRAWING

Course Objective: Machine drawing is an art and science which aids visualization, manufacture, inspection and documentation of machine parts and components for usage by engineers involved in design and manufacture.
Instructional Objective: This course will help students to study and draw assemblies and disassemblies of various mechanical components, to understand the working and use of various permanent and fixed fasteners, to learn and draw free hand sketches missing views, and computer aided drafting of commonly used mechanical parts.

No. of lectures per week: : 1
No. of tutorials per week: : 1
No. of practicals per week: : 3
Max Marks for theory paper: : 100
Max marks for sessionals: : 25
Total no of modules: : 4
Duration of theory examination : 4 hours

Weightage of marks:
Module I : Two questions of 15 marks each
Module II : Two questions of 15 marks each
Module III : One question of 35 marks
Module IV : One question of 35 marks
Module III and Module IV are compulsory. Answer one question each from Module I and Module II

MODULE 1 (1)

Introduction to machine drawing. Conventional representation of basic components

Limits, Fits and Tolerances: Introduction to limits, fits, tolerances. Methods of placing limit dimensions. Geometric tolerancing. Datum line and tolerance build up. Machining grades. Types of fits, selection of fits and their use in drawings.

Screw Fasteners: Screw thread nomenclature, forms of screw threads, Thread series, Thread profiles, Multi-start threads, right and left hand threads, bolted joints, studded joints, foundation bolts. Locking devices for nut. Limits and fits for threads.

Welded joints: Types of welded joints, representation of welds on drawings.

Riveted joints: Introduction, classification and terminology of riveted joints. Caulking and fullering for rivets

MODULE 2 (1)

Keys, cotter and pin joints: Types of keys, cotter and pin joints.
Shaft couplings: Rigid coupling, flexible coupling, flexible coupling, non-aligned coupling disengaging coupling.
Pipes and pipe joint: Joints for steam pipes and hydraulic pipes, union joint and expansion joint.
Free hand sketches: Free hand sketches of different joints and couplings.

MODULE 3 (1)

Assembly Drawings with Bill of Materials
(Part Drawings with dimensions should be given)

-Screw Jack
-Lathe Tail Stock
-Steam stop valve
-Machine vice
-Feed check valve
-Blow off cock
-Lathe tool post
-IC engine connecting rod

MODULE 4 (2)

Disassembly Drawings with Bill of Materials
(Pictorial view with dimensions should be given)

-Drill Jig
-Connecting rod
-Stuffing box
-Footstep bearing
-Eccentric
-Crane hook
-Tail stock of milling machine
-Plummer block

Assignments

At least THREE sheets on assembly and THREE sheets on disassembly should be done during the practical sessions. Among which at least TWO sheets on assembly and TWO sheets on disassembly should be done using the drafting software.

TEXT BOOKS

1. Siddheshwar N: Machine Drawing, Tata McGraw Hill Publications
2. Bhatt.,N.D.: Machine Drawing, Charotar Publications

REFERENCES

1. Gill P.S.: Machine Drawing, Tata Mc Graw Hill Publications
2. Parkinson A.C: Intermediate Drawing
3. SP: 46-1988.
4. Gopal Krishna: Machine Drawing, Subhash Publications

M.E. 3.3 APPLIED THERMODYNAMICS

Course Objective: This course aims at to provide a good platform to mechanical engineering students to understand and appreciate concept of dynamics involved in thermal energy transformation and prepare them to carry out experimental investigation and analysis at later stages of graduation.
Instructional Objective: To help students to gain understanding of fundamentals of thermodynamics and to realize and appreciate the application of the concepts and laws from experimental and engineering background.

Lecturer per week : 3 hour
Tutorial per week : 1 hour
Max. marks for theory paper : 100
Max. marks for sessionals : 25
Duration of the paper : 3 hour
Total no of modules : 4
No. of question from each module : 2
Total no of question to be answered : 5 (at least one question from each module)

MODULE – 1 (4+5+2=11)
LAWS OF THERMODYNAMICS

1.1. I Law of thermodynamics : Introduction, overview of basic concepts, statement of I law of thermodynamics-corollaries including PMM – 1, establishment of standard reversible processes, application and analysis of I law on non –flow and flow processes, transient and steady state flow processes, common flow devices, problem & solution techniques.
1.2. II Law of Thermodynamics: Introduction, Statements, COP & efficiency, observations including PMM-II Carnot theorems, thermodynamic temperature scale, Claussius theorem, entropy, change in entropy in irreversible process, lost work principle of increase of entropy, problem & solution techniques,
1.3. III Law of Thermodynamics: Introduction to statistical thermodynamics, statement concept (preliminary treatment only)

MODULE – 2 (3+5+3=11)
WORK POTENTIAL

2.1. Thermodynamic Relations: Introduction, Maxwell, Tds, Clapeyron equations-establishment and derivations only, Helmholt's and Gibb's functions.
2.2. Measure of Work Potential: Introduction, Availability, Irreversibility for flow and non flow cases- establishment and derivation, seconds law efficiency, quality of energy excergy, problems & solution techniques
2.3. Real Gas: Introduction, equation of state- Vanderwaal's, viral, law of corresponding states, problem & solution techniques.

MODULE – 3 (3+4+4=11)

WORKING FLUID

3.1. Properties of Pure Substance : Introduction, Definition, P-V-T surface, methods to determine mass function of steam, problem & solution techniques using steam table and Mollier chart.

3.2. Gasesous Mixture : Introduction, Dalton and Amagat's law, determination of properties of compositions, gravimetric and Volumetric analysis of mixture, problem & solution techniques.

3.3. Principles of Psychometry : Introduction, humidity, adiabatic saturation process, dew point, wet bulb temperature (WBT), psychometric chart, basic air condition process (preliminary treatment only), problems & solution techniques.

MODULE – 4 (5+5+2=12)

CYCLES

4.1. Air Standard Cycles: Introduction, air standard assumption, an overview of reciprocating engines, Otto, Diesel and Dual cycles-establishment, comparative analysis, application; problem & solution techniques.

4.2. Vapour Power Cycles : Introduction , Rankine, reheat and regenerative cycles- ideal and with component efficiency and losses, establishment, comparative analysis application; problem & solution techniques.

4.3. Refrigeration Cycles : Introduction. Reversed Brayton cycle, Vapour compression refrigeration cycle, analysis of cycles with out P-h charts properties of refrigerants.

TEXT

1. Wan Wylen , G.J. Sonnatag, R.E. and Borgnakke , C. (1996), Fundamentals of classical thermodynamics, John Wiley & Sons, Inc Singapore.
2. Nag, P.K. (1996), Engineering Thermodynamics, Tata McGraw Hill Pub., New Delhi.
3. Cengel Y.A, and Boles M.A.(2003), Thermodynamics – An Engineering Approach, Tat a McGraw Hill Pub., New Delhi.

REFERENCES

1. Rao, Y.V.C. (2003). Theory and problems of thermodynamics, Universities Press (India) Pub., Hyderabad.
2. Spalding D.B. and Cole, E.H. (1979), Engineering thermodynamics, The English Language Book Society, London.
3. Rogers, G.F.C. and Mayhew, Y.R. (1980), Engineering Thermodynamics, Longman Pub., Hongkong.

ME 3.4 ENGINEERING MATERIALS SCIENCE

Course Objective: To impart knowledge about different properties of wise range of metals in view of manufacturing process.

Instructional Objective: To give familiarity with various characteristics and structutasl property relationships, as well, as processing techniques of materials an to provide proficiency and confidence to the engineering graduates in making judicial material choices.

Lecturer per week	: 3 hour
Tutorial per week	: 1 hour
Max. marks for theory paper	: 100
Max. marks for sessionals	: 25
Duration of the paper	: 3 hour
Total no of modules	: 4
No. of question from each module	: 2
Total no of question to be answered	: 5 (at least one question from each module)

MODULE – 1 (4+7=11)

1.1. Crystal Structure and Defects: Unit cell, space lattices and crystal structures, crystal directions and planes. Point defects-vacancy, interstitial and foreign impurities, Schottky and Frenkel defects. Line defects- edge and screw dislocations, burgers vector, Surface defects- low and high angle grain boundaries, tilt, twist and twin boundaries.

1.2. Dislocation Theory and Plastic Deformation : Dislocation loop, dislocation motion, intersection of dislocations, jogs, dislocation sources, multiplication of dislocations, energy of dislocations. Deformation by slip, slip in a perfect lattices, slip by dislocation movement, critical resolved shear stress for slip, deformation by twinning, deformation by bands, yield point phenomena, strain hardening , strain aging, recovery, recrystallisation and grain growth.

MODULE – 2 (3+3+1+4=11)

2.1. Fracture: Types of fracture in metals, ductile fracture, theoretical cohesive strength of metals, Griffith theory of brittle fracture, ductile-brittle transition temperature, fracture toughness.

2.2. Mechanical Testing of Materials: Tensile, impact, hardness, fatigue, creep and formability tests.

2.3. Phase Diagrams : Constitution of alloy, phase rule, binary phase diagrams, lever rule.

2.4. Iron-Carbon Phase Diagrams : Phases in iron-carbon diagram, definition of structures, invariant reactions, changes in microstructure during slow cooling, critical temperature lines, isothermal transformations diagram, transformation on continuous cooling.

MODULE – 3 (4+3+2+2=11)

3.1. Heat Treatment: Heat treatment of steels - annealing, normalizing, hardening, tempering, hardenability, Jominy end quench test. Case hardening of steels - carburizing, cyaniding, nitriding, induction and flame hardening. Heat treatment of steels of non-ferrous metals and alloys, age hardening, thermo-mechanical treatment of steels.

3.2. Metallography: Metallography of steel, cast iron, brass and bronze, sample preparation, etching, optical microscope, TEM and SEM.

3.3. Power Metallurgy : Powder manufacture, blending or mixing, compacting, sintering, secondary operations, applications, advantages and limitations.

3.4. NDT TECHNIQUES: Radiography, magnetic particle inspection, fluorescent penetrant test, ultrasonic inspection, eddy current inspection.

MODULE – 4 (4+4+3=11)

4.1. Composite Materials : Classification, strengthening, mechanism in particulate, dispersion strengthened and fibre reinforced composites, characteristics of fibre reinforcing composites, elastics modulus under iso-stress and iso-strain condition.

4.2. Alloy Steels and Cast Irons : Purpose of alloying, effect of alloying elements, effect of common alloying element and their applications. Tool steels- classification, properties and typical applications. Classification, properties and applications of stainless steels and cast irons.

4.3. Non Ferrous Alloys: Composition, properties and applications of typical brassses and bronzes and aluminum alloys.

TEXT

1. Sydney H. Aver: Introduction to physical metallurgy, TMH, II Edition.
2. George E.Dieter, Mechanical Metallurgy , THM.

REFERENCES

1. Raghavan V: Elements of material science and engineering, PHI, IV Edition.
2. William D. Callister: Elements of material science and engineering, John Wiley & Sons, New York, IV Edition.

M.E. 3.5 FLUID MECHANICS

Course Objective : The study of fluid mechanics involves statics, kinematics and dynamics aspects of fluid. Some of the notable applications are in design of dams, flow of water in pipes, measurement and analysis of various parameters like pressure velocity. The course tries to cover the important aspects of Fluid mechanics and its application.
Instructional Objective: The course aims that students understand basic theory and numerical problems involved in various topics of Fluid mechanics. The course aims at the following:
1. The student should have knowledge of different properties of fluids.
2. They should know different pressure, velocity, discharging measuring instruments.
3. They should have knowledge of hydrostatic forces on surfaces.
4. They should understand the various concepts involved in dynamics, kinematics and turbulent flow.
5. They should understand boundary layer phenomenon.
6. They should have basic idea of Dimensional analysis and Modeling & analysis.

No of Lectures per week : 3 hours
No. of tutorials per week : 1 hour
Max. Marks for theory paper : 100
Max. Marks for sessionals : 25
Duration of theory examination : 3 hours
Total no. of modules : 4
No of questions from each module : 2
Total No. of questions to be answered : 5 (at least one question from each module with two compulsory question from any one module)

MODULE – 1 (2+4+5=11)

1.1.Properties of Fluids : Basic concepts and definitions, Classification and properties of fluids-surface tension and capillarity, compressibility and bulk modulus.
1.2. Fluid Statics: Liquid pressure and its types. Pascal's law of pressure, pressure variation in a static fluid, Measurement of pressure – Manometers: Simple U-Tube, Differential manometers, and Mechanical Gauges. Pressure at a point in a Compressible Fluid
1.3.Hydrostatic Forces on Surfaces: Total pressure and center of pressure on Vertical, Horizontal and inclined plane surfaces submerged in liquid.

MODULE – 2 (3+4+4=11)

2.1.Fluid Kinematics: Types of Fluid Flow, Discharge, Continuity equation, Lines of flow types of velocity potential function for 2-D Flow, Relationship between them and flow nets.
2.2.Fluid Dynamics : Equations of motion, Euler's equation. Bernoullis equation Practical application of Bernoullie's equation - horizontal and inclined venturimeter, Pitot tube. Impulse momentum equation, Kinetic energy & momentum correction factor.
2.3. Flow Through Pipes: Loss of head in pipes - major & minor losses, Hydraulic gradient and total energy line, Flow through siphon, Equivalent pipe -series &parallel pipes, Flow through nozzle, water hammer in pipes.

MODULE – 3 (6+5=11)

3.1.Turbulent Flow : Definition , Reynolds experiment, Darcy-weisbach's equation, Prandtl's mixing length theory, universal velocity distribution equation, Hydrodynamatically smooth & rough boundaries, Velocity distribution for turbulent flow in smooth & rough pipes.

3.2. Compressible Flow: Thermodynamics properties, Basic equation of compressible flow, Velocity of sound for adiabatic & isothermal process. Mach number & its variations, Mach angle, Zone of action, Zone of silence. Subsonic & Supersonic nozzle, stagnation properties

MODULE – 4 (6+6=12)

4.1. Dimensional Analysis: Dimensional of physical quantities, dimensional Homogenity, Buckinghams-π Theorem , Rayleigh'smethod, important dimensionless numbers.

4.2. Boundary Layer: Definitions: Laminar & turbulent boundary, boundary layer thickness & energy thickness. Total drag due to laminar & turbulent layers. Boundary layer separation & its control.

TEXT

1. Dr. R.K Bansal: A Text Book of fluid Mechanics and Hydraulic mechanics, Laxmi publications, New Delhi 2002.
2. Kumar D.S: Fluid Mechanics and Fluid Power Engineering S.K.Kataria & Sons
3. Modi P.N,.Seth S.M: Hydraulic &Fluid Mechanics Standard Book House

REFERENCES

1. Streeter V. I &. Wylie E. B "Fluid Mechanics" Mc Garw Hill
2. Jagdish Lal "Fluid Mechanics and Hydraulics" Metropolitan book company Pvt. Ltd.
3. R.K.Rajput "A Text book of Fluid Mechanics and hydraulic machines", S.Chand Company Ltd, New Delhi 2003.

ME 3.6 DIGITAL ELECTRONICS & MICROPROCESSORS

Course Objective: This course aims to help students to understand electronic control of mechanical parts.

Instructional Objective: To help students gain an understanding of the working of basic digital electronic circuits and microprocessor-based circuits.

Lecturer per week	: 3 hour
Tutorial per week	: 1 hour
Max. marks for theory paper	: 100
Max. marks for sessionals	: 25
Duration of the paper	: 3 hour
Total no of modules	: 4
No. of question from each module	: 2
Total no of question to be answered	: 5 (at least one question from each module)

MODULE – 1 (4+1+4+2=11)

1.1.Study of Number Systems & Codes :Unsigned binary numbers, signed binary numbers, Binary arithmetic- Addition & subtraction using 1's complement & 2's complement method. Introduction to Decimal, Binary, Octal & Hexadecimal number systems & their conversion from one form to another. Introduction to Gray codes, Excess-3 codes & ASCII codes.

1.2.Study Of Logic Circuits: Study of basic NOT, AND, OR, NAND, NOR,XOR & NOR gates with schematic symbol & truth table.

1.3.Study Of Boolean Algebra :Laws, rules & theorems of Boolean algebra, Sum of products form (SOP), products of sum form (POS) of Boolean functions. Study of Karnaugh Maps (K-maps) for 2, 3 & 4 variables only.

1.4. Combinational Logic: Analysis of Half Adder, Full Adder, Encoders and Decoders; Multiplexers and Demultiplexers,

MODULE 2 (3+2+6=11)

2.1. Study of Flip Flops: Study of clocked Set-Reset (SR) flip flop, JK flip flop, Toggle (T) flip flop, Delay (D) flip flop & Master slave JK (MSJK) flip flop with their schematic symbol, truth table & excitation table.

2.2.Study of Shift Registers: Study of Serial in serial out (SISO), Serial in parallel out (SIPO), Parallel un serial out(PISO), Parallel in parallel out (PIPO) shift registers.

2.3. Study of Counters : Study of Asynchronous counters with circuit diagram, truth table & waveforms (up counters m down counters & up/down counters). Study & design of Synchronous counters (up counters, down counters & up/down counters) using D or T flip flops only, & study of Ring counters.

MODULE 3 (5+6=11)

3.1. Microprocessor Architecture & Microcomputer Systems: Introduction to microprocessors, microcomputers, organization of a microprocessor based system, 8085 bus structure, Microprocessor architecture & Pin diagram of 8085. Timing Diagrams.

3.2. Semiconductor Memories & Interfacing : Basics, memory addressing, Types of memories (RAM & ROM) & Interfacing with 8085 & Interfacing of memory along with I/P, O/P devices & peripherals.

MODULE 4 (7+5=12)

4.1. 8085 Instruction Set: Data transfer instructions, Arithmetic instructions , Logical , Branch & machine control instructions , Conditional call & Return Instructions. Writing of simple assembly language programs, concept of stacks & subroutines.

4.2. Study Of Microprocessor Applications:- Designing scanned displays, Interfacing a matrix keyboard, Memory & Stepper motor.

TEXT

1. Malvino & Leach : Introduction to Digital Electronics, Tata McGraw Hill,.
2. Morris Mano : Digital Logic & computer Design, PHI, India.
3. Gaonkar R.S.: Microprocessor Architecture, Programming & Application, Wiley Eastern

REFERENCES

1. Mathur A.P : Introduction to Microprocessors, Tata Mc Graw Hill,.
2. Millman & Halkias :Integrated Electronics , Tata Mc Graw Hill,.
3. Floyd :Digital fundamentals ,.

M.E. 3.7. PRACTICALS IN APPLIED THERMODYNAMICS

Practical per week : 2 hours
Max marks for practical exam : 25
Duration of the practical exam : 2 hours

Course Objective : To learn to carry out experimental investigation on systems interacting with work and heat and to practically conform how they obey laws of thermodynamics.
Instructional Objective: To help students to gain hands-on experience on how to conduct experimental investigation and procedure a technical report based on the investigation.

List of Experiments
A. To investigate and ascertain the conformance of :
1. The first law of thermodynamics on petrol engine.
2. The second law of thermodynamics on petrol engine.
3. The first law of thermodynamics on diesel engine.
4. The second law of thermodynamics on diesel engine.
5. The first and second law analysis on air conditioning system.

B. Determination of mixture properties
6. To find the composition of exhaust of petrol engine (gravimetric/volumetric)
7. To find the composition of exhaust of diesel engine (gravimetric/volumetric)

C. Cycle analysis
8. On gas turbine

At least six experiments from the above list are to be conducted and an appropriate journal reporting the experiments is necessarily to be submitted.

List of Apparatus Required

Sr. No.	Equipment description	Quantity
1	Petrol engine	1
2	Diesel engine	1
3	Air conditioning test rig	1
4	Exhaust gas analyzer	1
5	Nozzle flow devices	1

Other Requirement:
A standard laboratory manual encompassing all the features of a technical report.

M.E. 3.8. PRACTICALS IN ENGINEERING MATERIAL SCIENCE

Practical per week : 2 hours
Max marks for practical exam : 25
Duration of the practical exam : 2 hours

List of experiments in Material Science and metallurgy

1. To draw the stress-strain curve and calculate (a) the elastic limit (b) yield strength (c) ultimate tensile strength (d) % of elongation (e) % of reduction in area (f) toughness (g) resilience of the given metal.
2. To measure the hardness of the given material using Brinell/ Rockwell/ Vicker's Hardness tester.
3. To measure the impact strength and notch sensitivity of the given metal.
4. To determine the capacity of the material to withstand repeated cyclic stress.
5. To determine the continuing change in the deformation of the material at elevated temperature below the yield point.
6. To determine the ductile - brittle transition temperature of the given metal.
7. To find the ability of the given metal to be formed into different shapes.
8. To study the microstructure of (a) mild steel (b) brass (c) cast iron.
9. To detect the presence of cracks/flaws in the given metal piece by magnetic particle crack detection method.
10. To detect the presence of cracks/flaws in the given metal piece by dye penetrant test.
11. Joining End Quench test.
12. With the help of muffle furnace to carry out annealing, normalizing, hardening, operation.

At least six experiments from the above list are to be conducted and an appropriate journal reporting the experiments is necessarily to be submitted

M.E. 3.9. PRACTICALS IN FLUID MECHANICS

No of hours per week : 2 hours
Duration of examination : 2 hrs.
Max. marks for practical : 25

List of experiments in Fluid Mechanics Laboratory

1. Verification of Bernoulli's theorem.
2. Calibration of a Venturimeter.
3. Calibration of a orificemeter
4. Calibration V-notch
5. Calibration of rectangular notch
6. Friction in pipes-Determination of coefficient of friction for a G.I. pipe
7. Frictional loss in pipe due to bend and nozzle
8. Reynold's Experiment.: Demonstration of Laminar and turbulent flow.

At least six experiments from the above list are to be conducted and an appropriate journal reporting the experiments is necessarily to be submitted.

M.E. 3.10. PRACTICALS FOR DIGITAL ELECTRONICS AND MICROPROCESSOR APPLICATIONS

Course Objective : To learn how digital circuits can be designed and implemented with and without microprocessors.

Instructional Objective : To help students to gain hands-on experience in designing, assembling, analyzing and debugging basic digital electronic circuits, and how to program a microprocessor circuit.

Practicals per week : 2 hours
Max. Marks for practical exam : 25
Duration of the practical exam : 2 hours

List of Experiments :
1. Performance of Logic Gates
2. Boolean Equation
3. De Morgan's Theorems
4. Performance of Universal Gates
5. Parity Generators and Checkers
6. Reduction using Boolean Algebra
7. Reduction using Karnaugh Map
8. RS Flip-Flop
9. JK Flip-Flop
10. Performance of Counters
11. Design of Course
12. Performance of Shift Registers
13. Parity Generators and Checkers
14. Simple Programs for the 8085 Microprocessor

At least six experiments from the above list are to be conducted and an appropriate journal reporting the experiments is necessarily to be submitted

List of Apparatus Required:
1. Bread boards
2. I.C.s
3. L.E.D.s
4. Wires
5. DC Power supply

Other Requirement:
A standard laboratory manual encompassing all the features of a technical report.

M.E.4.1 THEORY OF MACHINES-1

Course Objectives : This is an introductory level course, mainly dealing with kinematic analysis of linkages and the direct contact mechanisms. Basics on mechanism synthesis are also included. The course aims at initiating, mechanical engineering students, in the area of Synthesis and analysis of the mechanisms, In the process they will learn to analyze mechanical systems, in general.

Instructional Objective : The expected outcome is an ability to analyse mechanisms, get acquainted with the basics of synthesis process and develop appreciation for advanced topics in the field of Mechanisms and Machines.

Lectures per week : 3 hours
No. of practicals per week : 2 hour
Max. Marks for theory paper : 100
Max. Marks for sessionals : 25
Duration of theory examination : 3 hours
Total no. of modules : 4
No of questions from each module : 2
Total No. of questions to be answered: 5 (at least one question from each module)

MODULE 1 (2+6+3=11)

Introduction: Basic terminology, mobility criterion, four-bar, slider crank and Double slider crank chains and their inversions, Grashoff's linkage.

Kinematic of Particle and Rigid Body : Position displacement, velocity and acceleration of particle, intrinsic co-ordinates and path curvature, motion relative to a moving frame, Coriolis acceleration, Newton's law in nib-internal frame, Motion of a rigid body, angular velocity pf a rigid body: a vector, chassel's theorem.

Description of Some Common Linkages: Exact and approximate straight-line mechanism, steering gears, pantograph and universal joint.

MODULE 2 (11)

Velocity And Acceleration Analysis of Mechanisms : Analysis of mechanisms, having higher and lower pairs, by graphical; and analytical methods. Instantaneous centre of velocity, Arnhold-Kennedy theorem, body centrode and space centrode and their application.

MODULE 3 (5+6=11)

Kinematics Synthesis of planar mechanism : Task of synthesis and it's classification, synthesis of mechanism for three accuracy points using graphical and analytical techniques, Freudenstein's equation, Four bar coupler curves, Cognate linkages, Bloch's synthesis method, Practical consideration in mechanism synthesis.

CAMS : Different types of CAMS and followers and terminology for Cam- follower Mechanisms: follower motions : uniform, uniform acceleration and retardation , SHM, cycloidal their comparison, graphical synthesis of cam profile for a given follower and it's motion, polynomials cam, synthesis of follower motion from the given follower

acceleration variation with cam angle, pressure angle, and size of a cam, radius of curvature of the cam profile with roller follower to avoid undercutting, circular arc cam and tangent cams.

MODULE 4 (6+2+2+2=12)

TOOTHED GEARING :

Motion transmitted two curved surfaces in direct contact, law of gearing , classification of gears, involute and cycloidal gears, spur gear terminology, involumentry , path of contact , interference and undercutting, method of avoiding interference , non- standard gears.

Helical Gears: Terminology , Contact in two helical gears , contact ratio, comparison with spur gears.

Spiral Gears : Centre distance, velocity ratio, velocity of sliding , efficiency.

Worm and worm wheel: Terminology , application , efficiency.

Bevel Gears : Terminology , Tredgold's approximation.

Gear Trains : Analysis of Simple , Compound and epicyclic gear trains, automobile differential.

TEXT

1. Hamilton H. Mabie and CFharles F. Mechanism and dynamics of machinery, Rainholtz, john Wiley & Sons.
2. Jospeh Edward Shigley and John Jospeh Uicker Jr. Theory of machines and Mechanisms, Mc Graw , Hill International edition.
3. J. S. Rao and Dukkipati, Mechanism and Machine Theory , Wiley Eastern Limited.

REFERENCES

1. Irving H. Shames, Engineering Mechnaics, Prentice Hall of India Pvt. Ltd.
2. George H. Martin, Kinematics and Dynamics of Machines, McGraw-Hill international Book Company.

M.E.4.2 MECHANICS OF SOLIDS

Course Objectives : The objective of this course is to introduce students to the strength of Materials approach to analyze simple structural elements, subjected direct Tension/compression, Bending, Torsion and combination of these loads. This will help them to take up, at a later stage, design of machine elements and simple structures.

Instructional Objective : The course should prepare students to take up design of machine elements and further study in Theory of Elasticity and related topics.

Lectures per week : 3 hours
No. of Tutorials per week : 1 hour
Max. Marks for theory paper : 100
Max. Marks for Sessional : 25
Duration of theory examination : 3 hours
Total no. of modules : 4
No of questions from each module : 2
Total No. of questions to be answered : 5 (at least one question from each module)

MODULE 1 (4+4+3=11)

Introduction: Review of mechanics, static analysis of rigid systems. Stress. Strain. Hook's law, Poisson's ratio, modulus of rigidity, bulk modulus, relation between constants.

Uniaxial Deformation : Uniaxial tension/ compression, temperature stresses, statistically indeterminate problems.

Stress And Strain Analysis: 2-D stress and strain analysis, Mohr's circle, strain gage rosettes.

MODULE 2 (4+7=11)

Properties Of Areas: Centroid, Moment of inertial, principal axis of inertia, parallel axes of theorem and polar moment of inertia

BEAMS: Bending moment and shear force, relation between them, sign convention, Flexure formula, asymmetric bending, curved beams, stresses due to shear force, Shear stresses in beams of thin walled open cross sections, shear center for thin walled open sections such as "T" , channel, angle section, semi-circular section , (built-up section not include), deflection of beams, statistically in determine beams.

MODULE 3 (4+7=11)

Torsion: Torsion of circular shafts, close and open coil springs.

Struts And Columns: Struts and core of section, stability of columns , euler's critical load, for different end conditions of column , empirical formulas for bucking load.

Members Subject to Combined Loading : Shafts subjected to bending movement and twisting movement, members subjected to bending and directed tension/ compression.

MODULE 4 **(5+4+3=12)**

Introduction of Energy Methods: Strain energy under different loading conditions, Maxwell's theorem, Catigliono's theorems, deflection of structures using virtual load method.

Thick And Thin Cylinders: Thin cylinders subjected to internal pressure, thick cylinders, Lamme's equation.

Theories Of Failure: Various theories of failures and their limitations comparison and application .

TEXT

1. Gere James M., Timoshenko Stephen P., Mechanics of Materials, CBS.
2. Popv Egor P. Pearson Education (Singapore) Pvt. Ltd.

REFERENCES

1. Beer Ferdinand, Johnson E. Russel, Mechanics of Materials, Mc Graw Hill Book.
2. S. Ramamrutham, Strength of Materials, Dhanpat Rai Publishing Co. (P) Ltd.

ME 4.3 NUMERICAL TECHNIQUES & COMPUTER PROGRAMMING.

Course objective: To introduce students to various numerical techniques, enabling to solve problems which may not be intractable analytically. Implement the algorithm using C language.

Instructional Objective: to build ability to solve numerically linear system of equations, algebraic and transcendental equations, differential equations and evaluate integrals. Using C language implement the algorithm.

Lecture per week : 3hrs.
Practicals per week : 2hrs
Tutorials per week : 1hr
Max marks for theory paper : 100
Max marks for Sessional : 25
Duration of examination : 3hrs
Total no of modules : 4
No of questions from each module :2
Total no of questions to be answered :5(At least one question from each module)

MODULE 1 (5+4+2=11)

Solutions Of Equations: Solutions of non-linear equations of single variable using bisection method, false position method, Newton-raphson's method, secant method, (problem solving, algorithm and computer programming) order of convergence of these methods. Comparison of these methods.

MODULE 2 (5+6=11)

Finite Difference And Interpolation: Forward , Backward, Central , Divided differences, Difference tables. Lagrange's interpolation, Taylor's operator -d, Shift operator ‘e, averaging operator, derivations. difference of polynomials factorial polynomials. Newton's forward & backward difference interpolation, Newton's divided difference interpolation.(derivation, problem solving, algorithm and computer programming) Stirling's and Bessel's interpolation formula.

MODULE 3 (6+5=11)

Numerical Solution Of Differential Equations: Picard's methods, Taylor's series method, Euler's method, Modified Euler's method, Runge Kutta methods, Milne’s predictor - corrector method.(problem solving, algorithm and computer programming)

Numerical solution of Partial Differential equations: Solution of Laplace equation, heat equation and Wave equation by finite difference method.

MODULE 4 (6+6=12)

Numerical Integration : Newton- Cote’s Quadrature formula , trapezoidal rule, Simson's 1/3 and 3/8 rules,Weddle’s rule (problem solving, algorithm and computer

programming). Romberg's integration (Richardson's Extrapolation).Comparison of the above methods and their error estimation.

Solution of linear algebraic equation; Gauss Elimination method, Gauss Jordan method, Jacobi's method, gauss-Siedel iterative method (problem solving, algorithm and computer programming). Concept of ill conditioned and well conditioned system comparison of the above method.

TEXT

1. Grewals B. S. : Numerical Methods, Khanna publications
2. Kandasamy P : Numerical Methods S. Chand and Co, New Delhi
3. Dr. D.S.C. Engineering Mathematics Part III

REFERENCES

1. E. Balaguruswamy : Numerical Methods
2. S.S.Sastry : Introduction Method of Numerical Analysis
3. V.Rajaraman : Computer Oriented Numerical Methods

ME 4.4: ELECTRICAL TECHNOLOGY

Course objective: to familiarize with electrical machines, which mechanical engineers are to deal with in their fields

Instructional Objective: to impart concepts of electrical machines

Lecture per week	: 3hrs.
Practical per week	: 2hrs
Max marks for theory paper	: 100
Max marks for sessionals	: 25
Duration of the paper	: 3hrs
Total number of modules	: 4
No of questions from each module	: 2

Minimum number of questions to be answered from each module:1

Total no of questions to be answered : 5

All module carry equal weightage

MODULE 1 (6+5=11)

Principles of electromechanical energy conversion: DC machine-Construction & emf equation.

DC Motor: principles, torque-equations voltage equation, torque-equations, motor characteristics, speed control, starting

Three Phase Induction Motor: Principle, construction, slip, torque-slip characteristics, starting, speed control.

MODULE 2 (3+3+3+2=11)

Single phase Induction Motor: Principle of operation of split phase type, capacitor start motors.

Stepper Motors: Types, principle of operation.

Synchros: Construction, principle of operation and applications.

Servomotors: DC servomotor, two-phase ac servomotor.

Drives: Concept of an Electrical Drive, Classification, characteristics and braking of dc motors.

MODULE 3 (4+4+3=11)

Working principle, construction, torque equations of the following analog instruments (a) PMMC (b) Moving iron (c) Electrodynamometer types, Shunts and multipliers for PMMC type instruments and extension of range.

Electrodynamometer Wattmeter: construction, torque equation.

Induction type Energy meter: construction, torque equation. Measurement of power and energy.

MODULE 4 (4+4+4=12)

Potentiometers: DC potentiometer: slide wire type and Laboratory type (Crompton's Potentiometer), applications.

AC Potentiometer: Drysdale Polar type Potentiometer.

AC bridges : For measurement of inductance, capacitance and frequency: Maxwell Bridge, Wagner's Earth bridge.

Illumination: Definitions, laws of Illumination

Electrical heating: advantages, principle of resistance heating, high frequency eddy current heating, dielectric heating.

TEXT

1. A Text Book of Electrical Technology-- B.L Theraja.(Vol II)
2. A Course in Electrical and Electronics Measurement and Instrumentation---A.K. Sawhney

REFERENCE

1. Electrical Power : J.B. Gupta
2. A First Course on Electrical Drives: S.K. Pillai

M.E.- 4.5 : MANUFACTURING TECHNOLOGY - I

Course Objective: This subject covers the basic processes followed for manufacturing different products. Basically this subject cover casting, metal forming, welding and plastic processing. After studying this subject student will be able to understand how the different products are manufactured, their process details, and process parameters. Understanding of this subject is perquisite for mechanical engineering subjects like machine design, production planning and control, process engineering, etc.

Instructional Objective: To impart knowledge on basic manufacturing processes, which will be essential to understand advanced courses being offered in the area of manufacturing.

No of Lectures per week	: 3 hours
No. of tutorials per week	: 1 hour
Max. Marks for theory paper	: 100
Max. Marks for sessionals	: 25
Duration of theory examination	: 3 hours
Total Marks	: 125
Total no. of modules	: 4
No of questions from each module	: 2

Total No. of questions to be answered : 5 (at least one question from each module)

MODULE I (11)

Casting- Advantages, basic steps in making sand casting.

Pattern , Functions, types, pattern making allowances

Core Functions, types, core boxes, core making, core print, chaplet.

Moulding , Moulding sand in-gradients, general properties of moulding sand, sand testing (analytical treatment), green sand moulding, dry sand moulding

Cupola furnace , construction, operation, charge calculation (analytical treatment).

Special Moulding Processes , CO_2 Moulding, Shell Moulding, Plaster mould casting, investment casting, centrifugal casting- true, semi and centrifuging.

Permanent mould casting (Die casting) , advantages, limitations and applications.

Pressure die casting , hot chamber, cold chamber.

Casting Design , Pouring and feeding, progressive and directional solidification, typical gating system and its elements; Gates, Risers, design calculation (analytical treatment). Casting defects, inspection and testing of casting

MODULE II (11)

Welding advantages, classification, types of welds, edge preparation for butt welds, weldability and metallurgical aspects of welding.

Thermit welding , thermit crucible, thermit pressure (plastic), thermit non-pressure (fusion) welding.

Gas welding, Oxy-acetylene gas welding, types of flames, welding techniques, welding equipments.

Arc Welding , Submerged Arc Welding (SAW), Tungsten inert gas welding (TIG), Metal inert gas welding (MIG), Metal active gas (CO2) welding (MAG), Electroslag welding (ESW)

Resistance welding , spot, seam projection, upset butt, flash butt, percussion, high frequency

Brazing and soldering

Solid state welding , smith, cold pressure, friction, explosive, ultrasonic, diffusion

Radiant energy welding , laser beam welding (LBW), electron beam welding (EBW)

MODULE III **(11)**

Metal forming , classification of forming processes , hot and cold working, based on stress, primary and secondary, strain hardening

Rolling , types of rolling mills, roll product terminology, force and geometrical relationships, force and power calculation. (Analytical treatment)

Forging advantages, classification- open die forging and closed die forging, hammer and press forging, hand and machine forging; equipments used, force calculation (analytical treatment).

Extrusion , Direct, Indirect, hydrostatic, impact extrusion, equipment used Rod / Wire drawing , principle, rod drawing, tube drawing, wire drawing, drawing die and its construction, equipments used, preparation of rod for wire drawing, heat treatment of wire, protective metallic coatings.

MODULE IV **(12)**

Fabrication of plastics , casting, compression moulding (hot), transfer moulding, cold moulding, injection moulding, extrusion, thermoforming, foam moulding, machining of plastics, finishing and assembly operation.

Processing of rubbers and elastomers.

Processing of ceramics , fabrication, machining, joining.

Fabrication of composite materials , laminar composites, fiber reinforced composites, lamination and lamination type processes

TEXT BOOKS

1. P.N. Rao , Manufacturing Technology (Casting, forming and welding), TATA McGraw Hill (TMH).
2. Suresh Dalela, R. Shankar , A text book of production Technology, Galgotia Publications Pvt. Ltd.

3. G.K. Lal, S.K. Chaudhary , Fundamentals of Manufacturing Processes, Narosa Publishing House

REFERENCES

1. E. Paul DeGarmo, J.T. Black, Ronald A. Kohser-Materials and processes in Manufacturing, Prentice Hall India (PHI).
2. Roy A. Lindberg - Processes and Materials of Manufacture, Prentice Hall India (PHI).
3. J.S. Campbell - Principles of Manufacturing Materials and Processes, TMH
4. Amitabha Ghosh, Asok Kumar - Manufacturing Science, East West Press Pvt. Ltd. New Delhi.
5. Hiene, Loper, Rosenthall - Principles of Metal Casting, TMH.
6. O.P. Khanna - A Text Book of Foundry Technology, Dhanpat Rai Publication.
7. P.L. Jain - Principle of Foundry Technology, TMH.
8. G.E. Dieter - Mechanical Metallurgy, McGraw Hill International.
9. R. Narayana Samy - Metal Forming Technology, Ahuja Book Publisher.
10. A.C. Davies - Welding, Cambridge
11. O.P. Khanna - A Text book of Welding Technology, Dhanpat Rai Publication.

ME 4.6 ENERGY CONVERSION

Course objective: this course aims to provide all the core concepts of energy conversion and allied applications. This provides a platform to pursuer to understand and appreciate the real life applications of energy conversion. At the end of the course the pursuer will be in a position to carryout experimental investigation on prim-movers. With the associated practical slots the students will get a complete exposure on Internal Combustion engines.

Instructional Objective: to help students to build theory with analytical ability in the area of energy conversion. To enable students to carryout experimental investigation on Internal Combustion engines and thereupon to draw proper conclusions. To know the fundamentals of jet propulsion with theory of gas turbine.

Lecture per week : 3hrs.
Tutorials per week : 1hr
Max marks for theory paper : 100
Max marks for sessionals : 25
Duration of examination : 3hrs
Total no. of modules : 4
Total no. of questions from each module :2
Total no. of questions to be answered :5(At least one question from each module)

MODULE-1 (1+4+2+2+2=11)

1. CYCLE ANALYSIS AND PREPARATORY SYSTEMS

1.1 Basics : Introduction, overview of working principles of I.C.Engines, overview of ideal cycle and comparison.

1.2 Fuel Air Cycles & Their Analysis : Introduction, Fuel Air Cycles & their significance, Variable Specific heat, Dissociation, Effect of no. of moles, Comparison of Air Standard & Fuel Air Cycles, Effect of operating Variables, Problem and Solution Technique.

1.3 Actual Cycles & Their Analysis : Introduction, Comparison of thermodynamic & Actual Cycles, various losses.

1.4 Carburetion : Introduction, air-fuel requirement, carburetion, simple carburetor-air feel ratio derivation, compensating devices, demerits, multi-point fuel injection (MPFI) system, simple problems and solution technique

1.5 Fuel Injection System : Introduction, injection system with schematic diagram (elementary treatment only)

MODULE-2 (1+2+3+3+2=11)

2. Fuels and Combustion

2.1 Ignition System : Introduction, circuitry, description (elementary treatment only)

2.2 Combustion In Spark Ignition Engines : Introduction, Stages of combustion in S.I. Engines, Flame front propagation, factors influencing the flame speed, Abnormal combustion, the phenomenon of knock in S.I. Engine, Effect of Engine variables on Knock.

2.3 Combustion In Compression Ignition Engines : Introduction, Stages of Combustion C.I. Engine, Factors affecting the Delay period, the phenomenon of knock in C.I. engines, Comparison of knock in S.I and C.I. Engines.

2.4 Super Charging : Introduction, Supercharging Systems, Turbo-charging, Characteristics of Supercharged Engines, Method of Super Charging, Limits of Supercharging.

2.5 Fuels : Important qualities of Engine fuels, rating of C.I. and S.I. Engine fuels. Alternative fuel renewal sources (preliminary treatment only)

MODULE-3 (5+5+2=12)

3. Testing and Performance

3.1 Measurement : Introduction, Measurement of frictional power , Willian's line method, Morse test, Retardation test, indicated power-indicated diagram, Brake power , Prony Brake, Rope Brake, Eddy Current, Swinging field Dynamometer, Measurement of Fuel Consumption, Air Consumption-air box method, Speed, Exhaust & Coolant Temperature.

3.2 Thermal Calculations :Load, speed and performance characteristics, Engine power, Engine Efficiencies, Variables affecting performance characteristics, Heat balance with dry and wet exhaust calculations, performance Maps.

3.3 Emission and its control: SI CI engine emissions and their comparison, environmental effect of air pollution.

MODULE-4 (3+3+5=11)

4.1 Lubrication Systems : Introduction, Lubrication Systems types and working principles with schematic diagram (theoretical treatment only)

4.2 Cooling Systems: Introduction, types and working principles with schematic diagram (theoretical treatment only)

4.3 Jet Propulsion : Introduction, air standard cycles, types, deviations, thrust and propulsive power and efficiency calculations, problem and solution technique, rocket propulsion (theoretical treatment only)

TEXT

1. Ganesan V. (2003): Internal Combustion Engines Tata McGraw Hill, New Delhi
2. Gill. P.W, Smith J.H. and Ziurjs E.J. (1974), Fundamentals of Internal combustion engines as applied to reciprocating gas turbine and jet propulsion power plants, Oxford & IBH pub. New Delhi
3. Pulkrabek W.W. (2002), Engineering fundamentals of Internal combustion engine Prentice Hall of India Pub.,New Delhi

REFERENCES

1. Mathur M.L &. Sharma R.P: A Course in Internal Combustion Dhanpat Rai & sons.
2. Domkundwar V.M: I.C. Engines Dhanpat Rai & co.
3. Taylor: The Internal Combustion Engines Vol. I & II

ME 4.7 PRACTICALS IN NUMERICAL TECHNIQUES & COMPUTER PROGRAMMING.

No. of Practicals per week: 2 hrs.
Max. marks for practicals : 25
Duration of examination : 2 hrs

1. Solution of non-linear equations using bisection method
2. Solution of non-linear equations using bisection method
3. Newton forward difference interpolation formula
4. Lagrange's interpolation formula
5. Solution of differential equations using Euler's method
6. Solution of differential equations Runge-Kutta fourth order method
7. Numerical integration using Simpson's 1/3 rule
8. Numerical integration using Weddle's rule

ME 4.8 PRACTICALS IN ELECTRICAL TECHNOLOGY

No. of Practicals per week: 2 hrs.
Max. marks for practicals : 25
Duration of examination : 2 hrs

List of Experiments to be carried out as practicals in the Laboratory

1. Speed control of DC shunt / compound motor.
2. Ward Leonard method of speed control of DC motors
3. Study of 3paint starter
4. To find out various parameters of induction motars by direct load test
5. Study of DOL and star delta starter.
6. Measurement of power by two wattmeter methods
7. Measurement of energy by 1-Ø energy meter
8. Measurement of unknown resistance by Kelvity bridge
9. Measurement of insulation resistance by Megger
10. Study of DC potentiometer
11. Direct load test on 1-Ø Induction motor
12 Study of Temperature control in electric heater

At least six experiments from the above list are to be conducted and an appropriate journal reporting the experiments is necessarily to be submitted.

ME 4.9 PRACTICALS IN MANUFACTURING TECHNOLOGY - I

No. of Practicals per week: 2 hrs.
Max. marks for practicals : 25
Duration of examination : 2 hrs

List of Practicals on :

1. Preparation of sand mould.
2. Preparation of casting
3. Smith forging
4. Arc / gas welding

Practical as above are to be conducted and the jobs are to be submitted for assessment

ME 4.10 PRACTICALS IN ENERGY CONVERSION

No. of Practicals per week: 2 hrs.
Max. marks for practicals : 25
Duration of examination : 2 hrs

Course Objective :

- To carry out tests to investigate the performance of prime movers.
- To impart how to measure important performance parameters of experimental investigation on prime movers.

Instructional Objectives:

- To help students to gain hands-on experience on how to conduct experimental investigation on prime movers.
- To impart how to draw conclusions from appropriate measures base on the graphical plots in conjunction with the concept learnt the theory.
- To prepare a technical report based on the experiments conducted.

List of Experiments

A. To investigate the behaviour of prime movers by:

- Load test on Spark and compression Ignition Engine.
- Speed test on Spark and compression Ignition Engine.
- Performance test and draw heat balance sheet.
- Performance test on Gas Turbine.

B. Determination of :

- Effect of compression ratio on engine performance
- Frictional Power using:
  - Willan's line
  - Morse test
  - Retardation test
  - Motoring test
- Air fuel requirement in SI engine
- Fuel and exhaust gas analysis
- Composition of pollutants.

At least six experiments from the above list are to be conducted and an appropriate journal reporting the experiments is necessary to be submitted.

List of Apparatus Required

Sr. No	Equipment Description	Quantity
1	Petrol engine multi-cylinder	1
2	Diesel engine multi-cylinder	1
3	Variable compression ratio engine test rig	1
4	Exhaust gas analyzer	1
5	Gas turbine test rig	1

Other requirements:

A standard laboratory manual encompassing all the features of a technical report

M.E.5.1 Machine Design-I

Course Objective:

- To teach students how to apply the concepts of stress analysis, theories of failure and material science to analyze, design and/or select commonly used machine components.
- To illustrate to students the variety of mechanical components available, their design and emphasize the need to continue learning.

Instructional Objective: Help the students to apply the knowledge of Engineering Mechanics, Mechanics of solids and Engineering Materials science in the design of machine components.

Lecturer per week	: 3 hour
Practicals per week	: 2 hour
Max. marks for theory paper	: 100
Max. marks for sessionals	: 25
Duration of the paper	: 3 hour
Total no of modules	: 4
No. of question from each module	: 2
Total no of question to be answered	: 5 (at least one question from each module)

Module-I (2+3+3+4)

1. BASIC CONCEPTS: Meaning of design with special reference to machine design. Definition and understanding of various types of design, Elaborated Design process

2. GENERAL DESIGN CONSIDERATIONS

.Concept of tearing, bearing, shearing, crushing, bending etc. Selection of materials, Basic criteria of selection of material, their designation, mechanical properties of those materials in brief. Study of Stress concentration, factor of safety under different loading conditions,

3.SIMPLE PART DESIGN

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

4. DESIGN OF FLEXIBLE MEMBERS: Design of Flat belt, V-belt and rope (steel wire), Design of the pulley for the same. Selection of Chain Drive

Module-II (4+4+2+2)

6. DESIGN OF FASTERNERS

6.1 RIVETS: Design of rivets for boiler joints, lozenge joints (uniform strength joint), eccentrically loaded riveted joints

6.2.BOLTS: Understanding the various stresses/ failure in bolted joints, design of cylindrical covers, basic and eccentrically loaded bolts

6.3.WELDS: Design for various loading conditions in torsion, shear or direct load, eccentrically loaded welded joints.

6.4.MISCELLENEOUS: Design of spigot and socket cotter joint, Gib and Cotter joint and knuckle joint.

Module-III (6+3)

7. DESIGN OF TRANSMISSION SHAFT

Design of both solid and hollow shafts for transmission of torque, bending moments and axial forces, Design of shaft for critically speed, Design of shaft for rigidity and Design of stepped shafts for assembly

8. DESIGN OF KEYS AND COUPLINGS:

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

Module-IV (6+4)

9. MECHANICAL SPRINGS:

9.1 Stresses and deflections of helical springs – Extension -compression springs – Springs for fatigue loading. Natural frequency of helical springs – Energy storage capacity – helical torsion springs – Co-axial springs,

9.2 Design of Leaf springs, Belleville springs, Rubber springs.

Text books

1. Bhandari V.B.: Design of machine elements , Tata McGraw Hill
2. Khurmi R.S. Machine Design S.Chand and Co.
3. Sharma P.C. & Aggarwal D.K. Machine Design , Kataria & sons.

References:

1. Shigley J.E., Mischke C.R.: Mechanical Engineering Design, McGraw Hill International.
2. Spotts M.F. Shoup T.E. Design of machine elements, Prentice-Hall International.
3. Hamrock B.J, Jacobson, Schmid S.R.: Fundamentals of machine elements McGraw Hill International.
4. Black & Adams: Machine Design, McGrawHill International.

Prescribed Design Data Hand Book: PSG Design Data Hand Book.

M.E. 5.2 Engineering Economics and Management

Course objectives: The objective of the course is to produce graduates who combine a sound knowledge of engineering with an understanding of the principles of manangement and economics.

Instructional Objectives:

- Understand the major capabilities of economics such as GDP, GNP etc.
- Be able to recognize, formulate, and analyze cash flow models in practical situations. Understand the assumptions underlying these models such as discounted cash flow calculations, including present-worth and rate-of-return calculations, financial analyses, accounting and depreciation capital budgeting, etc., and the effects on the modeling process when these assumptions do not hold.
- Be able to understand management concepts such as planning, organising, staffing, leading and control..

Lectures per week	: 03
Tutorials per week	:01
Max. marks for theory paper	: 100
Max mks for practicals	: 0
Max. mks for sessionals	: 25
Duration of paper	: 3 hours
Total no of modules	: 4
No of questions from each module	: 2
Total no of questions to be answered	: 5

Module 1

No. of hours: 17

General Economics

Demand and supply analysis, Demand and Supply curves, Market equilibrium
National Income terms – GDP, GNP, NDP, NNP, Methods of calculating national income
Price index, Inflation
Estimation/Forecasting of demand
Economies and Diseconomies of scale
Mergers, Takeovers and Acquisitions

Module 2

No. of hours: 15

Accounting and Capital Budgeting

Environment of Finance
Forms of Business
Regulatory framework

Taxes
The financial system
Preparation of income statement, Balance sheet, Fund flow statement, Ratio analysis – Liquidity, Leverage and Profitability ratios
Working Capital management– Determinants of wkg. cap., Financing of wkg. cap., Dangers of excess and scarce wkg. cap.
Depreciation – Causes, Methods - Straight line method, Declining balance method, Sum of years digits method, Sinking fund method
Capital Budgeting – Process, need and importance, Methods of project evaluation – Payback period, Accounting rate of return, Internal Rate of return, Net Present Value,
Sources of long-term finance
Retained earnings
Equity capital
Preference capital
Debenture capital
Term loans

Module 3

No. of hours: 10

General Principles of Management

Introduction to Management, Functions of a manager, Different schools of management – Scientific, Modern Operational and Behavioural
Nature of Objectives
MBO
Process
How to set objectives
Benefits and Weaknesses
Organisation
Formal and Informal Organisation
Organisational levels and the Span of management
Factors determining an effective span

Organisation structure : Departmentation
Departmentation by
Simple numbers
Time/Enterprise function
Territory
Customer
Process
Product

Matrix Organisation
Strategic Business Unit

Decentralisation and Delegation
Factors determining the degree of decentralization

Module 4

No. of hours: 13

Managing People

Motivation
Carrot and stick theory

Maslow's hierarchy of needs theory
Herzberg's motivation-hygiene theory,
Vroom's Expectancy theory,
McClelland's needs theory,
Theory X, Theory Y

Leadership
Ingredients of leadership
Trait theory
Behavioural theory
Contingency theory

Human Resource Management and Selection
Defn. of Staffing
Overview of the staffing function
Selection process, techniques and instruments
Recruitment and selection, Appraisal methods

Communication
Communication function in organizations
Basic communication process
Communication in an organisation
Barriers in communication
Principles of effective communication

Controlling
Basic control process
Critical control points and standards
Types of controls
Requirements for effective controls

Textbooks :

1. R.L. Varshney and K.L. Maheshwari, *Managerial Economics* Sultan Chand and Sons, 1994
2. Harold Koontz and Heinz Weihrich, *Management, A global perspective* 10th Edition McGraw Hill, 1994

References :

1. Petersen and Lewis, *Managerial Economics*, PHI
2. Prassanna Chandra, *Fundamentals of Financial Management* 3rd Edition Tata McGraw Hill, 2001
3. Richard Lynch and Robert Williamson *Accounting for Management*, *Planning and Control* 3rd edition, Tata McGraw Hill

M.E. 5.3 HEAT AND MASS TRANSFER

Course Objective: Understanding the physics of heat transfer phenomena helps gain insights about nature, refrigeration & air-conditioning, energy production and processing, manufacturing & materials processing. Knowledge in heat transfer helps to optimize processes and gain production, energy and cost efficiencies.

Instructional Objective: Heat transfer studies enables us to:

- Understand how heat is transferred (the modes)
- Calculate the rate at which heat is transferred
- Estimate the temperature distribution within a body experiencing heat transfer

No. of Lectures per week:	:3
Number of tutorials per week:	:1
Max. marks for theory paper	:100
Max. marks for sessionals	:25
Duration of paper	:3 hours
Total no of modules	:4
No of questions from each module	:2
Total no of questions to be answered	:5

MODULE I

Introduction Applications of heat transfer in engineering field. Modes of heat transfer, Fourier's law of heat conduction, Newton's law of cooling, Stefan-Boltzmann's law of radiation. Significance of thermal conductivity. Variation in thermal conductivity with temperature.

(03 Hours)

Conduction: Three dimensional heat conduction equation in Cartesian coordinate for anisotropic material for unsteady state condition, thermal diffusivity and reduction to Fourier equation, Laplace equation and Poisson's equation. One dimensional steady state heat conduction through a plane wall, cylindrical wall and sphere, Analogy between Heat flow and electricity, heat conduction through a composite slab, cylinder and sphere, overall heat transfer coefficient, Critical radius of insulation, thermal contact resistance and economic thickness of insulation. Concept of thermal resistance and conductance.

(04 Hours)

One dimensional steady state heat conduction with heat generation:-
Conduction heat transfer through plane wall, solid cylinder, hollow cylinder and sphere with heat generation. Practical problems involving heat generation.

(03 Hours)

MODULE II

Extended Surfaces
Heat transfer through extended surfaces. Fins of different shapes. Derivation of differential equation for fins with constant cross section with different boundary conditions. Effectiveness and efficiency of a fin. Error in the measurement of temperature in a thermo-well. Heat sinks- types and applications.

(03 Hours)

Transient Heat Conduction:
Approximate solutions, Analytical solutions. System with negligible internal resistance. Biot and Fourier numbers. Criteria for neglecting internal temperature gradient. Heisler charts.

(03 hours)

Heat Exchangers

Classification of Heat exchangers, Overall heat transfer coefficient, Fouling factor, the LMTD Method for Heat exchanger analysis, Correction factors for cross-flow and multipass flow, the Effectiveness-NTU method for Heat exchanger analysis.

(04 Hours)

MODULE III

Convection
Mechanism of convection, Classification of convection, Introduction to hydrodynamic and thermal boundary layer. Laminar and turbulent flow over and inside a surface.
Dimensional analysis of free and forced convection. Physical significance of the dimensionless parameters – Nusselt number, Reynolds number, Prandtl number, Grashoff number, Stanton number, Rayleigh number, Peclet number & Graetz number

(04 Hours)

Natural convection:
Physical mechanism, Definitions, Empirical correlation's for free convection heat transfer over horizontal plate, vertical plate and cylinder.

(03 Hours)

Forced convection:
Empirical correlation's for heat transfer in laminar and turbulent flow over a flat plate across cylinders and in a circular pipe. Concept of hydraulic diameter.

(03 Hours)

MODULE IV

Thermal Radiation

Fundamental concepts, Spectrum of electromagnetic radiation, Black bodies radiation, Theories of Radiation and Black body radiation laws (Kirchoff's law, Planck's distribution law, Wien's displacement law and Stefan Boltzmann's law). Surface emission, radiative properties of a surface. Grey, black, white and real surface. Solid angle, intensity of radiation, Lambert's cosine law.

(04 Hours)

Radiation exchange between surfaces

Heat exchange by radiation between two finite black surfaces. Radiation shape factor, use of shape factor charts. Irradiation, radiosity, electrical network method of solving problems. Heat exchange between non-black bodies and Heat exchange between two infinitely parallel planes, cylinders and spheres. Radiation shields, Gas radiation, and solar radiation. **(03 Hours)**

Mass Transfer

Introduction to Mass transfer, Modes of Mass Transfer, Fick's law of diffusion, General mass diffusion equation in stationary media, Steady state diffusion through a plain membrane, Steady state equimolar counter diffusion, Diffusion in Gases, liquids and solids, The mass-transfer coefficient, Evaporation process in the atmosphere , Mass convection. **(03 Hours)**

Text Books

1. P.K. Nag, "Heat Transfer" : Tata McGraw Hill
2. Thirumaleshwar, "Heat Transfer", Pearson Education
3. C.P. Kothandraman, " Fundamentals of Heat and Mass Transfer" New Age International Publishers.

References :

1. Ozisik N.M: "Heat transfer – A basic approach", McGraw-Hill
2. Holman J.P: "Heat Transfer", McGraw-Hill
3. Taine & Petit: "Heat Transfer" : Prentice Hall
4. Yunus A. Cengel : "Heat transfer – A Practical Approach" : McGraw Hill
5. J.P. Holman, "Heat Transfer", McGraw hill
6. Frank P Incropera, David P De Witt, , "Fundamentals of Heat Transfer", Wiley, Eastern Limited.
7. Sukhatme S. P.,"A text book on Heat Transfer" Orient Longmans Ltd.
8. "Heat and Mass Transfer Data Book" : C.P. Kothandraman , S. Subramanyan. New Age International Publishers.

M.E. 5.4 MANUFACTURING TECHNOLOGY II

Course overview: This course provides a comprehensive knowledge and insight into the machining techniques in a modern workshop. Beginning with the fundamentals of metal cutting and operations on the basic workshop machines, the course extends to cover the cutting tool materials, tool geometry, dynamometers and economics involved in a machining workshop. Due stress is also given to gear manufacturing and unconventional machining processes.

Instructional objectives: This course will enable the students to understand the following

- Basics of metal cutting and the operations performed on the commonly used workshop machines like lathe, milling, drilling, shaping, planning, broaching etc.
- Cutting tool geometry, tool material requirements and commonly used tool materials.
- Gear manufacturing and unconventional machining processes.

Lecture per week	**3 hours**
Tutorials per week	**1 hour**
Max marks for theory paper	**100**
Max marks for sessionals	**25**
Total no. of modules	**4**
Total no of questions to be answered	**5 (At least one question from each module)**

MODULE I

Theory of metal cutting Wedge shaped tool and its features, orthogonal and oblique cutting, Chip formation and types of chips, built-up-edge, chip thickness ratio, velocity diagram, shear strain in metal cutting.

Concept of feed, speed, depth of cut and cutting forces in turning, milling, drilling and grinding. Effect of various parameters on cutting forces

Effect of different parameters on surface finish. Expression for the height of feed ridges.

Merchants Theory and its modification– Expression for shear plane angle

MODULE II

Cutting Tool Materials - Basic requirements, selection, study of high carbon steel, high speed steel, cemented carbides, coated tools, ceramics and diamonds
Tool life and tool wear –Definitions, symptoms of end of tool life, tool life equations, tool wear mechanisms, wear types, tool life criteria. Effect of built-up-edge and tool angles on tool life.

Single point cutting tool geometry - Definitions and significance of various angles in plan view and in different sections. Relationship between these angles.

MODULE III

Machining operations - Basic operations performed on lathe, milling, grinding, broaching, shaping, and planning.

Economic of machining - Introduction, machining time and associated cost, criteria for feed choice, expressions for optimum cutting velocity under different criteria, restrictions for feed choice

Machinability - Measures, different criteria for assessing machinability, machinability ratings.

Cutting fluids - Objectives, requirements, classification, selection of cutting fluids.

Dynamometers – Introduction, requirements, dynamometers for turning, milling, drilling and grinding operations.

MODULE IV

Unconventional Machining – Introduction and necessity. Ultrasonic Machining, electric discharge machining, electrochemical machining, abrasive jet machining, laser beam machining, electron beam machining

Gear Manufacturing - Gear cutting processes - Gear hobbing, Gear shaping, Gear lapping, Gear grinding and Gear broaching.

Text Books

1. Rao P. N., *Metal Cutting*, Tata Mc Graw Hill
2. Lal G. K., *Manufacturing Science*, Narosa publishing house

References

1. Juneja B. L. & Sekhon G. S., *Fundamentals of metal machining and machine tools*, Wiley Eastern Ltd
2. Trent E. M., *Metal Cutting*, Butterworths
3. Amitabh Ghosh & Mallik A.K., *Manufacturing science*. EWP
4. Shaw.M.C., *Metal cutting principles* , CBS Publishers and distributors
5. Production Technology –HMT
6. E. Paul DeGarmo, J.T Black, Ronald A. Kohser, *Materials and Processes in manufacturing*, PHI

M.E.5.5 Theory of Machines-II

Course Overview

This course aims it providing basics of Dynamics of Machinery. Emphasis on basic principles and there applications to various mechanical systems.

Instructional Objective:

After completion of the course, students will be in position to carry out dynamic analysis of the mechanical systems. They will also appreciate the need for vibration analysis in design engineering..

Lectures per week	: 03
Tutorials per week	:01
Max. marks for theory paper	: 100
Max. mks for sessionals	: 25
Duration of paper	: 3 hours
Total no of modules	: 4
No of questions from each module	: 2
Total no of questions to be answered	: 5

MODULE I

No. of Hrs. 15

Static Force Analysis of Four-bar, Reciprocating Engine Mechanism, Spur Gears, Cam follower Mechanism.

Rigid Body Motion. Newton's and Euler's Equations. Balancing of Rotating Body, Gyroscopic Moment.

Dynamic force Analysis of Four-bar linkage.

Virtual work Principle as applied to Mechanisms.

MODULE II

No. of Hrs. 10

Dynamics of Reciprocating Engine Mechanism, inertia effect of Reciprocating mass and Connecting rod, T-θ diagram, Fluctuation of Energy and speed, Flywheel and Governors[1]

Balancing of Reciprocating masses, Multi-cylinder in-line Engines, V-engines. Opposed piston Engines, Partial Balancing of Locomotives and it's effect. (No Numerical on coupled Locomotives, only the concept and need for coupled Locomotives.)

[1]*No numericals, emphasis on need of Flywheel and a Governor, their comparison, and necessary attributesof Governor Mechanism.*

MODULE III

No. of Hrs. 15

Free vibration of Single Degree Freedom damped and undamped system. Periodic motion.

Forced Vibration of Single Degree Freedom system by harmonic forcing function, Excitation of the system by harmonic support motion, Principle of Vibration measuring

instruments. Vibration of Single Degree Freedom System by Rotating Unbalance, Vibration Isolation.

MODULE IV

No. of Hrs. 10

Whirling of shafts, critical speed.

Two degree of freedom system free vibration, Exact Analysis, natural frequencies and mode shapes.

Numerical methods for multi-degree freedom systems: Rayleigh's method, Dunkerley's method and Holzer's method.

Text books

1. Ambekar: Theory of Machines and Mechanisms, PHI
2. Grover: Mechanical Vibrations. S. Chand & Co.

References:

1. Shigley Uicker: Theory of Machines and Mechanisms, Mc Graw Hill.
2. Rao and Dukkipati: Theory of Mechanisms and Machines. New age International
3. Ghosh A. and Malik A.K.: Theory of Mechanisms and Machines, East west Publishers
4. Rao S.S. Mechanical Vibrations, Pearson Education.
5. Rao J.S., Gupta: Theory and Practice of Mechanical Vibrations, New Age International.
6. Mairovitch: Mechanical Vibrations, Mc Graw hill Int.

M.E. 5.6 Quality Engineering and Management

Course Objective: While living in the era of globalization where issues like six sigma in business process management are given the topmost priority, it becomes rather mandatory to learn various issues involved in quality. To analyze such issues the tool statistics is a must. This course primarily aims at to impart such knowledge to the pursuer so that he/she can understand the fundamental problems in quality and design ways to monitor them and methods to improve upon the process thereafter using the tool statistics.

Instructional Objective: The pursuer at the end of the course will be able to:

- Understand randomness in field and model it
- Collect and analyze data pertaining to quality issue
- Design and implement control chart in a typical manufacturing scenario
- Understand and adopt acceptance sampling plan in engineering field

Lectures per week	: 03
Tutorials per week	:00
Max. marks for theory paper	: 100
Max mks for practicals	: 0
Max. mks for sessionals	: 25
Duration of paper	: 3 hours
Total no of modules	: 4
No of questions from each module	: 2
Total no of questions to be answered	: 5

Module-1: Modeling Process Quality

(3+6+6)

1.1 Probability Preliminary: Definition, conditional events, total probability, Baye's theorem; Random variable- characteristics- mean, variance, distribution function, E and V- operators, moment generating function (MGF), function of one dimensional random variable, problems and solution procedure

1.2 Probability distributions:

1.2.1 Discrete distributions: Bernoulli trial, Binomial, Geometric, and Poisson-establishment, Mean, Variance and MGF derivations, application-memoryless property and reproductive property, numericals and solution procedure

1.2.2 Continuous distributions: Uniform, Exponential, and normal- establishment, mean, variance and MGF derivations, application-memoryless property, reproductive property, Central Limit Theorem, normal approximation to binomial, numericals and solution procedure

Module-2: Inference about Process Quality

(1+6+8)

2.1 Preliminary: Definitions, sampling distributions- Normal, Student t, Chi-square and F distributions (only structure and concepts without theorems and proofs)

2.2 Method and Measurement of Process Parameter:

2.2.1 Point estimation: Definition, properties-unbiased, efficient and consistent; Maximum likelihood estimation for point estimator.

2.2.2 Confidence interval estimation: Definition, confidence interval of single and double population on mean and difference in means, variance known and unknown, confidence interval on variance(s) of normal distribution of single and two populations-calculations and solution procedure

2.3 Tests of Hypotheses: Introduction, Type I and II errors, O.C curve, Statistical analysis- on test on mean and equality of two means of single and two populations, variance(s) known and unknown, on variance and variances of single and two normal population(s), choice of sample size, Test for Goodness of fit - discrete and continuous distributions mentioned in § 1.2 with working rule, Test for independence-concept, working rule, calculations and solution procedure

Module-3: Statistical Quality Control

(2+8+4+3)

3.1 Methods and philosophy: Introduction, Quality definition and brief history of evolution, methods and philosophy of statistical process control- assignable and chance causes, problem solving tools-histogram, Pareto chart, Cause and Effect diagram, scatter diagram (concepts only)

3.2 Statistical Process Control:

3.2.1 Control charts for variables: statistical basis, development and use of sample mean & range and sample mean and standard deviation charts, charts based on standard values, interpretation, analysis of pattern, Type I and II errors, Average Run Length (ARL), Average Time to Signal (ATS), selection of sample size, Operating-Characteristic (O.C) function, application, solution procedure, numericals and cases discussion.

3.2.2 Control charts for attributes: Control charts for non-conformings (p, np charts)-Statistical basis, development and operation, variable sample size, Type I and II errors O.C function and ARL calculations application, solution procedure, numericals and cases discussion.

Control charts for non-conformities (C, U charts)-Statistical basis, development and operation, variable sample size, Type I and II errors, O.C function, application, solution procedure, numericals and cases discussion

Module 4: Acceptance Sampling

(9+4)

4.1 By attributes: Single, double and Multiple sampling plans-calculation of Probability of acceptance, O.C Curve- sensitivity; MIL-STD (rejection plan) and Dodge-Romig system (rectification plan)-standard terminology and computation, referring standard

tables and calculations, design of single, double sampling plan, use of Cameron table-Dodge-Romig, single, double and multiple-MIL-STD system; sequential sampling plan-design and applicability

4.2 Principle of Statistical Process Improvement:

4.2.1 Process Capability Analysis: Natural Tolerance Limits, process dispersion, process capability Ratio -potential and actual, interpretation and use, application, solution procedure, numericals and cases discussion

4.2.2 Process Improvement: Concept of variance reduction, Introduction to six sigma management- evolution, sigma level, methodology and tools, implementation roles (Conceptual treatment only).

Text:

1. Montgomery D. C. (2001), Introduction to Statistical Quality Control, 4th edition, John Wiley & Sons, Inc., New York,
2. Grant E.L. and Leavenworth R.S.(2000), Statistical Quality Control, 7th Edition, McGraw-Hill publisher, New Delhi.
3. Montgomery D. C. Runger C. G. (1999), Applied statistics and probability for engineers, 2nd Edition, John-Wiley & Sons, Inc., New York,

References:

1. Johnson A. R. (1996), Probability and Statistics for engineers, Prentice Hall of India, New Delhi
2. Smith M. G. (2004), Statistical process control and Quality improvement, 5th Edition, Pearson Education, Delhi,
3. Zaidi (1997), SPC concepts, methodologies and tools, Prentice Hall of India, New Delhi
4. Juran G. M., Gryn M. F. (1995), Quality planning and analysis: from product development through use, 3rd Edition, Tata McGraw Hill, Pub., New Delhi.
5. Mitra A. (2002), Fundamentals of Quality Control and improvement, 2nd Edition, Pearson Education, Delhi.
6. Paranthaman D. (2000), Quality Control, Tata McGraw Hill, Pub., 11th Edition, New Delhi.

Me. 5.7 Practicals In Heat And Mass Transfer

Course Objectives:

- To understand the modes of heat transfer.
- To apply the basic laws of heat transfer.
- To gain insights into operational ranges, behavioural trends and shortcomings across different heat transfer equipments.

Instructional Objectives:

- Heat transfer analyses on various heat transfer setup using the basic laws .

No. of Hours per week :2 hours

Max marks for practicals :25

List of Experiments

1. To determine thermal conductivity of insulating material using Fourier's law of heat conduction.
2. To determine the effectiveness of a parallel flow heat exchanger using Logarithmic mean temperature difference.
3. To determine the effectiveness of a counter exchanger using Logarithmic mean temperature difference.
4. To determine the outlet temperatures of a parallel flow heat exchanger using ε- NTU method.
5. To determine the outlet temperatures of a counter flow heat exchanger using ε- NTU method.
6. To calculate the Stefan – Boltzmann's constant using the Stefan – Boltzmann's law of Radiation.
7. To determine the overall heat transfer coefficient of Pin-fin for Natural convection and determine the effectiveness of the Pin –fin.
8. To determine the overall heat transfer coefficient of Pin-fin for Forced Convection and determine the effectiveness of the Pin –fin.

M.E. 5.8 Practical in Manufacturing Technology II

Course overview: This course provides hands on experience to the students to work on the workshop machines like lathe, milling, drilling, shaping and planning.

Instructional objectives: This course will enable the students to have practical experience of the following operations:
Turning, facing, taper turning, thread cutting, knurling, drilling and gear cutting.

Practical per week	**2 hours**
Max marks for practical	**25**
Duration of practical examination	**2 hours**

Practicals:

I. Three machining jobs involving following operations:

- Plain Turning
- Facing
- Step turning,
- Taper turning,
- External and internal thread cutting,
- Knurling
- Eccentric
- Forming
- Drilling

Machining time calculation for each job.

II. One job on gear cutting operation.

M.E. 5.9 Practicals in Theory of machines II

Course Objective:

- To verify experimentally, the basic principles studied in the course work.
- To understand and implement experimental methods in Mechanical Engineering

Instructional Objectives:

Students to attain ability to:

- Design experiments keeping in mind the objective.
- Prepare and present the results along with relevant graphs.
- Draw conclusions, discuss results and ascertain the quantum and the sources of errors in the experiments.

Practical per week: 2 Hrs
Maximum mark for practical: 25
Duration of practical exam: 2Hrs

List of experiments:

This is representative list and leaves scope for designing new experiments relavant to the course. At least six experiments to be conducted and presented in journal.

1. Dynamic balancing of rotors on balancing machine.
2. Verification of gyroscopic rule.
3. To draw characteristic curve for Spring Controlled Governor.
4. To draw characteristic curve for Gravity Controlled Governor.
5. Determine mass moment of inertia of a given body using Tri-Filler suspension.
6. Determine damping ratio in a damped single degree freedom system.
7. Vibration measurement using Vibration Meter.
8. Vibration analysis using Vibration Meter and Filter.
9. Verification of Dunkerley's rule to determine natural frequency of multi degree freedom system.
10. To draw response of single degree freedom system to varying frequency of excitation on non-dimensional plane.

List of graphical work.

- Four sheets on Force Analysis.
- Two sheets on Balancing of rotating masses in several planes.
- One sheet on Synthesis of cam profile

5.10 Practicals in Quality Engineering Management

Teaching Schedule: P : 2 (hrs per week)
Scheme of Examination: Viva : 25 marks

Course Objective: to provide hands-on on data collection and analysis, setting up a control chart for a given process and therefore providing platform to improve manufacturing process

Instructional Objective: to provide a field exposure and involving them to understand and appreciate quality issues.

The following are the list of practical knowledge to be imparted:

- Simulate / collect field data and carryout data analysis
- Using EXCEL and/or any other valid software to analyze a simulated process on the following:
  - Construction of trial control chart
  - O.C function and analysis
  - Capability analysis
- Sequential sampling- a case discussion with acceptance and rejection lines
- Investigation on Multiple sampling Plan with a case and hence drawing O.C. curve
- Checking density function and probability law for the random variable listed in the theory course using a software
- Testing and analysis of hypothesis testing using a numeriacal/ case and hence drawing O.C curve with sensitivity

Other Requirements:

- The above investigations are to be reported in an appropriate and journal format journal
- As the practicals is more of software application, an standard manual encompassing all the features of a technical report

Pre-requisites:

- Set theory, descriptive statistics, software knowledge on EXCEL

M.E.6.1 INDUSTRIAL ENGINEERING

Course Overview: This course provides a comprehensive insight into the work study aspect of the jobs, wherein the method of doing a job is analyzed through diagrams and charts with an aim to find a better and safer method. Various procedures for timing a method are studied. Due emphasis is also laid on job evaluation and value engineering.

Instructional objectives: This course will enable the students to analyze the work content of the jobs, develop more efficient ways of doing a job and set time standards for the jobs.

Lectures per week **3 hours**

Tutorials per week **1 hour**

Max marks for theory paper **100**

Max marks for sessionals **25**

Total number of modules **4**

Total number of questions to be answered —5 (at least one question from each module)

Duration of Theory paper **3 hrs**

MODULE I

Productivity – Definition, measurement, scope. Partial and total productivity. Efficiency and effectiveness .Means of increasing productivity

Job Evaluation – Definition, objectives, procedure. Job description and Job specification Methods of job evaluation - ranking, job classification or grading, point system and factor comparison

Incentives – Definition, need, characteristics, types of incentives plans.

MODULE II

Work Study – Definition, objectives, procedure. Work content analysis. Work study as a means of improving productivity. Human factor in the application of work study.

Method Study – Definition, objectives, procedure. Selection of a job. Recording techniques - charts and diagrams [Charts-Outline, flow process, two handed, multiple activity and travel chart. Diagrams-Flow and string diagram]

Principles of motion economy. Use of human body, arrangement of the work place, design of tools & equipments

MODULE III

Work Measurement – Definition, objectives. Techniques of work measurement

- Time study - Definition, procedure. Job selection, elemental break up of job, performance rating , allowances, calculation of standard time
- Work sampling - Definition, procedure, determination of sample size.
- Standard data
- Predetermined motion time system

MODULE IV

Value Engineering – Concept, principle, methodology and scope.

T P M – Introduction, similarities and differences between T P M and T Q M, types of maintenance, T P M targes - O P E ,O E E, steps in introduction of T P M in an organization, organisation structure, pillars of T P M

Text Books

1. Introduction to work study by ILO
2. Kumar B., *Industrial Engineering*, Khanna publishers
3. Martand Telsang, *Industrial production management*, S. Chand

Reference

1. Ralph M. Barnes, *Motion and Time study. Design and measurement of work*, Wiley.
2. Benjamin W. Niebel, *Motion and Time study,* Mc Graw Hill
3. Benjamin Niebel and Andris Freivalds, *Methods , Standards and Work design,* Mc Graw Hill

M.E. 6.2 Machine Design-II

Course Objective:

- To teach students how to apply the concepts of stress analysis, theories of failure and material science to analyze, design and/or select commonly used machine components.
- To illustrate to students the variety of mechanical components available and emphasize the need to continue learning.
- To teach students how to apply mechanical engineering design theory to identify and quantify machine elements in the design of commonly used mechanical systems.

Instructional Objective: Help the students to apply the knowledge of Engineering Mechanics, Mechanics of solids and Engineering Materials science in the design of machine components.

Lecturer per week : 3 hour
Practicals per week : 2 hours
Max marks for Orals : 25
Max. marks for theory paper : 100
Max. marks for sessionals : 25
Duration of the paper : 3 hour
Total no of modules : 4
No. of question from each module : 2
Total no of question to be answered : 5 (at least one question from each module)

Module-I (5+3+5)

1.1 Design of Clutches: Torque transmitted by a clutch single plate, multi-plate, cone and Internal expanding clutches. Design of clutch plate, pressure plate, springs & lever. Introduction to one-way clutch.

1.2 Brakes: Braking torque. Block and band brake, internal expanding brake. Self locking and self energizing brakes. Limiting pressure, heating of brakes, disc brakes.

1.3 Machine Tool Elements: Elementary treatment on Design of beds, slide ways, spindles- material selection, design of strength and rigidity of parts.

Module-II (5+3)

2. BEARINGS:

2.1. Journal Bearings: Types of lubrication, viscosity Petroff's law, Stable lubrication, Thick-film lubrication, Introduction to hydrodynamic theory. Types of Journal bearings- Bearing Modulus – Full and partial bearings –Clearance ratio – Heat dissipation of bearings, bearing materials – journal bearing design

2.2 Ball and roller bearings – Static loading of ball & roller bearings, Bearing life.

Module-III (8+4)

3. Spur & Helical Gear Drives:

3.1 Spur gears- Helical gears – Load concentration factor – Dynamic load factor. Surface compressive strength – Bending strength – Design analysis of spur gears – Estimation of centre distance, module and face width, check for plastic deformation. Check for dynamic and wear considerations.

3.2 Worm gears: Force analysis, friction in worm gears, bending & wear strength of worm gears. Thermal consideration of worm gears. Selection of materials.

Module-IV (2+2+2+4)

4. Engine Parts

4.1Connecting Rod: Thrust in connecting rod – stress due to whipping action on connecting rod ends

4.2 Cranks and Crank shafts: strength and proportions of over hung and center cranks Crank pins, Crank shafts.

4.3 Pistons, Forces acting on piston: Construction Design and proportions of piston. Cylinder, Cylinder liners,

5. Design of power screws: Design of screw, Square ACME , Buttress screws, design of nut, compound screw, differential screw, ball screw- possible failures.

Text books

1. Bhandari V.B.: Design of machine elements , Tata McGraw Hill
2. Khurmi R.S. Machine Design S.Chand and Co.
3. Sharma P.C. & Aggarwal D.K. Machine Design , Kataria & sons.

References:

1. Shigley J.E., Mischke C.R.: Mechanical Engg. Design, McGraw Hill International.
2. Spotts M.F. Shoup T.E. Design of machine elements, Prentice-Hall International.
3. Hamrock B.J, Jacobson, Schmid S.R.: Fundamentals of machine elements McGraw Hill International.
4. Black & Adams: Machine Design, McGraw Hill International.

Prescribed Design Data Hand Book: PSG Design Data Hand Book.

Me 6.3 Gas Dynamics And Turbomachineries

Course Objective: Knowledge in gas dynamics helps to analyse compressible flow devices. Understanding the eulerian energy exchange using the velocity triangles helps the learner to understand the range of turbomachine equipment both power absorbing and power generating.

Instructional Objective: This course enables:

- Design and modeling of turbomachinery.
- Estimate the energy transfer and the various losses in equipment.
- Understand the compressible flow phenomenon.

Lectures per week	:3
Tutorials per week	:1
Max. marks for theory paper	:100
Duration of paper	:3 hours
Total no. of modules	:4
Total no. of questions from each module	:2
Total no. of questions to be answered	: 5(At least on question from each module with two compulsory questions from any one module)

MODULE 1

PRINCIPLES OF TURBOMACHINERY: The turbomachine, Positive displacement machines and turbomachines, Static State, Concept of stagnation condition. Application of first and second laws to turbomachines, Efficiency of turbomachines.

ENERGY EXCHANGE IN TURBOMACHINES: The Euler turbine equation, Velocity triangles, Fluid energy changes, Impulse and reaction, Turbines- utilization factor, Specific speed.

CONSERVATION LAWS FOR COMPRESSIBLE FLOW: Conservation of mass and continuity equation, Conservation of momentum and momentum equation, Conservation of Energy and energy equation.

MODULE 2

CONCEPTS OF COMPRESSIBLE FLOW : Velocity of sound, Mach number and its significance, Various regions of flow, Physical difference between various flow regions, Kinetic form of steady flow energy equation, Reference speeds of compressible flow, Steam thrust and impulse function, Effect of compressibility on dynamic properties, Steady one dimensional compressible flow of perfect gas

ISENTROPIC FLOW: Governing equations, Effect of area variations, Reference states and isentropic flow relations, Supersonic nozzles, Differential equations governing flow with area change, Adiabatic flow.

MODULE 3

FLOW THROUGH NOZZLES AND DIFFUSERS: Operation of Nozzles under varying pressure ratio, under expansions and overexpansion in Nozzles, Losses in Nozzles, Supersaturated Flow of through steam nozzles, Performance of Diffusers.

STEAM TURBINES: Classification of Steam turbine, Impulse staging, Compounding of Steam turbines, Velocity diagram, Condition for maximum efficiency of Impulse Turbine, Most economical ratio of blade speed to steam speed for a two row velocity compounded wheel, Reaction turbine, Blade height in a reaction turbine, Losses in a steam turbine, Maximum gross stage efficiency of a 50% Parsons reaction turbine, Reheat factor.

MODULE 4

HYDRAULIC TURBINES: Hydraulic power utilization, Hydrograph and water power, Classification of water turbines, The Pelton wheel, Velocity triangles, Turbine efficiency and volumetric efficiency, Working proportions of Pelton wheels, Francis and Deriaz turbines, Velocity triangles and efficiencies, Design of Francis turbine, Propeller and Kaplan turbines. The draft tube

CENTRIFUGAL AND AXIAL- FLOW PUMPS: The centrifugal pump, Some definitions, Pump output and efficiencies, Multi-stage centrifugal pumps, Axial flow pump.

TEXT BOOKS :

1.SARKAR B.K. : Thermal Engineering , Tata McGraw Hill Publications

2. P. BALACHANDRAN. Fundamentals of Compressible Flow, Ist Edition, Prentice Hall of India, New Delhi, 2007.

REFERENCE BOOKS :

1. KADAMBI V. , MANOHAR PRASAD : An Introduction to Energy Conversion vol III, New Age International Publishers , New Delhi, 1997.

2. SOM S.K., BISWAS G. Introduction to fluid mechanics and fluid machines ,Tata McGraw Hill Publications.

3 YAHYA S.M: Fundamentals of compressible flow , New Age International Publishers

4. YAHYA S.M. :Turbines , Fans and Compressors, Tata McGraw Hill Publications

5. AJOY KUMAR, GN SAH. Thermal Engineering, Narosa Publications, New Delhi, 2004.

M.E.6.4 Engineering Measurements & Metrology

Course Objectives:
On completion of this subject a student should be able to:

- identify and appreciate the importance of standards
- relate geometric tolerances to dimensional errors
- differentiate between the various fundamental measurement approaches
- perform and interpret error analyses
- understand the components and requirements of measurement systems
- possess knowledge of the sources of measurement errors and how their influence may be reduced

Instructional objectives: Help the students to lean the principle, construction, operation and application of different measuring instruments used to measure different mechanical quantities.

Lecturer per week : 3 hour
Max. marks for theory paper : 100
Max. marks for sessionals : 25
Duration of the paper : 3 hour
Total no of modules : 4
No. of question from each module : 2
Total no of question to be answered : 5 (at least one question from each module)

Module-I (3+9)

1 **Introduction** : Uses of Measurement, Measurement of Length, Angle and Surface, Scope of Applied Metrology, Standardization.
1.1 Important Terms: Sensitivity, Magnification, Repeatability, Calibration, Readability, Reproduceability, Response Time.
1.2 Precision and Accuracy: Difference between Precision and Accuracy, Factors affecting accuracy of the measuring system, General rules for accurate measurement, Precautions to avoid inaccuracies during measurement.
1.3 Reliability. Comparison Terminology of Reliability, Precision and Accuracy.
1.4 Error : Definition of Error, Sources of Error, Classification of Error, Errors likely to creep in Precision measurement, Comparison between Systematic Error and Random Error, Other Types of Error and Analysis, Classification and Analysis of measurement error.
2. **Linear and Angular Measurement**
2.1 Linear measuring instruments: Vernier, micrometer, interval measurement, Slip gauges and classification, interferometery: optical flats,
2.2 Comparators: Mechanical, pneumatic and electrical types, applications.
2.3 Angular measurements:-Angle gauges, Sine bar, optical bevel protractor, angle Decker – Taper measurements.

Module-II (11)

3. **Limits, Fits and Tolerances**.

3.1 Interchangeability: Introduction, Advantages and Types

3.2 Limit Systems. Limit, fit, tolerances, tolerance built up, types of fits, selective assembly.

3.3 In brief earlier limit system (Nowall and BS 164) ISO/Indian Standard limit fit system

3.4 Selection of limit, geometrical tolerance. Limit gauging-Taylor's principle.

3.5 Geometric Dimensioning and Tolerancing: Introduction, Standard symbols and terminology, standard drawing, practice, and their interpretation.

Module-III (7+4)

4. **Form Measurement**

4.1 Measurement of screw threads-Thread gauges, floating carriage micrometer

4.2 measurement of gears-tooth thickness-constant chord and base tangent method-Gleason gear testing machine

4.3 Radius measurements-surface finish, straightness, flatness and roundness measurements.

5. **Laser and Advances in Metrology**

5.1 Precision instruments based on laser-Principles- laser interferometer-application in linear, angular measurements and machine tool metrology

5.2 Coordinate measuring machine (CMM)- Constructional features – types, applications digital devices- computer aided inspection.

5.3 Machine Vision applications in Metrology.

Module-IV (10)

6. **Measurement of Displacement, Force, Torque, Pressure, Temperature and Flow:**

6.1. Displacement measurement: Working principle of linear potentiometer, differential transformers, piezoelectric transducers, Hall effect transducers.

6.2. Force and torque measurement: The metallic resistant strain gauge, piezo electric load cell, eddy current dynamometers, strain gauges in rotating shafts.

6.3. Pressure measurements: Strain gauge pressure cell, Mc Leod gauge, calibration of pressure gauges.

6.4. Temperature measurements: Thermo couples, thermisters, optical pyrometers. Calibration of temperature measuring devices.

6.5. Determination of count, event per unit time (EPUT) and time interval: Electronic counters, EPUT meters, time interval meters, Stroboscope.

Text Books:

1. R.K.Jain, " Engineering Metrology ", Khanna Publishers,
2. Elanchezian "Engineering Metrology" Umesh Publications
3. R.S.Sirohi and H.C.Radhakrishna, " Mechanical Measurements ",New Age International

References:

1. Gaylor, Shotbolt and Sharp, " Metrology for Engineers ", O.R.Cassel, London,
2. T.G.Beckwith Mahangoni, Lienhard, " Mechanical Measurements ",Pearson Education.
3. Thomas, " Engineering Metrology ", Butthinson & Co.,
4. E.O. Doeelin, D.N.Malik, “ Measurement systems” Tata Mc Graw Hill.
5. Connie Dotson, Roger Harlow, R.L. Thompson,: “ Fundamentals of Dimensional Metrology” Thomson Delmar Learning.

M.E. 6.5 Mechatronics

Course Objective:

- To learn the basics of control systems and system modeling in engineering and application of concepts in process and manufacturing industries.
- To learn various types of sensors and signal conditioning elements used in mechatronics.
- To provide a glimpse of data presentation and data acquisition systems.
- To learn the basics of hydraulics and pneumatics and their application in industries.
- To understand the various electrical devices used in mechatronics.
- To introduce the students to microcontroller architecture and programming.
- To know about the basic elements of a CNC machine.
- To make the students aware of the recent developments and trends in mechatronics

Instructional Objective: Help the students to apply the knowledge of electrical and electronics engineering in the field of mechanical engineering for automation, process control and computer integrated manufacturing.

Lecturer per week	: 3
Tutorials per week	: 1
Max. Marks for theory paper	: 100
Max. Marks for sessional	: 25
Duration of the paper	: 3 hour
Total no of modules	: 4
No. of question from each module	: 2
Total no of question to be answered	: 5 (at least one question from each module)

MODULE-1 (12 hours)

1. INTRODUCTION TO MECHATRONICS: Definition, Open & closed loop control systems, Basic elements of closed loop systems , Case studies of microprocessor based controllers, Introduction to PLC.

2.CONCEPTS OF CONTROL ENGINEERING: Transfer function, Laplace transform, First order & second order systems, Systems with negative feedback, Basics of

Proportional, derivative, Integral ,PI , PID controllers, Digital controllers, Introduction to SIMULINK.

3.SENSORS AND TRANSDUCERS: Performance terminology of sensors , Photoelectric sensors, Inductive & capacitive proximity sensors, Optical encoders-types, Tachogenerator, Microwave & laser sensors, Limit switches, Flow sensors, Selection of sensors, Manufacturing applications of sensors.

MODULE-2 (12 hours)

4. SIGNAL CONDITIONING: Operational amplifier, Integrating & Differential amplifiers, Comparators, Protection, Filtering, Analog to Digital Conversion, Digital to analog converter, Multiplexers, Digital signal processing.

5. DATA ACQUISITION & PRESENTATION: Data acquisition system, Data loggers, LED & LCD displays, Alarm indicators, Add on cards, Elements of a data acquisition & control system, Virtual instrumentation, Data acquisition with lab view.

6. ELECTRICAL ACTUATION SYSTEMS: Relays, Solenoids, Stepper Motors- Types, specifications & control, servomotors**.**

MODULE-3 (14 hours)

7. PNEUMATIC AND HYDRAULIC ACTUATION SYSTEMS: Introduction, Advantages of Pneumatic/Hydraulic systems, the concept of Power Transmission, Pneumatic and Hydraulic systems, Control Valves, Pressure control Valves, Electro pneumatics, Rotary Actuators.

8. INTERFACING OF I/O SYSTEMS: Introduction, Basic I/O interfaces, - Isolated & memory mapped, Direct memory access, Communication with external devices- Polling, Interrupt, Parallel & serial Interfacing, RS232C standard

9. SYSTEM MODELS: Mathematical Models, Electrical system Building Blocks, Electrical and Mechanical Analogies , Fluid system Building Blocks, Thermal system Building Blocks.

MODULE-4 (14 hours)

10. INTRODUCTION TO MICROCONTROLLERS: The 8051 microcontroller, Architecture, Assembly language programming, Assembling and running an 8051 program, Program counter & ROM space , Data types and directives, Flag & PSW register , Register banks & stacks, I/O ports & their functions, Pin diagram**.**

11. MECHATRONIC ELEMENTS: Introduction, Machine Structure, Slip stick phenomenon, Antifriction, Hydrostatic & aerostatic guide ways, Recirculation, Ball screw, Antifriction bearings.

12. RECENT TRENDS IN MECHATRONICS: Embedded systems, Machine vision, Wireless LAN, Bluetooth, RF-ID & bar code identification, USB, Smart sensors. Networking of sensors, Distributed digital control systems, Ethernet, Microelectromechanical Systems

Text books:

1. Bolton.W. Mechatronics, Addison Wesley Longmans, Delhi.
2. C.R. Venkatramana, Mechatronics 2nd edition, Sapna Book House, Bangalore
3. M. Chidambaram, Computer control of processes, Narosa Publishing House

References:

1. TM.A. Mazidi, J.G. Mazidi, R. Mckinlay "The 8051 Microcontroller & Embedded Systems" Prentice-Hall of India, 2006
2. Sabrie Soloman, "Sensors and Control Systems in Manufacturing", McGraw-Hill Book Co., 1987
3. Histand, etal, Introduction to Mechatronics, McGrawHill, Inc. USA
4. Nagrath I.J., & Gopal M, "Control system Engineering." Wiley Eastern Reprint
5. Rajkamal "Embedded Systems" TMH Publication
6. Devdas shetty:etal, Mechatronics system Design, Thomson learning
7. Dan Necsulescu"Mechatronics" Pearson Education Asia.
8. HSU "MEMS and Microsystems design and manufacture" Tata McGraw Hill.

M.E. 6.6 Operations & Project Management

Lectures per week	:	3 hours
Tutorials per week	:	1 hour
Max marks of theory paper	:	100
Max marks for sessionals	:	25
Total number of modules	:	4
Total number of questions to be answered	:	5

Course Overview

Operations Management is the systematic direction and control of the processes that transform inputs into finished goods or services. Operations is one of the primary functions of a firm. While marketing induces the demand for products and finance provides the capital, operations *produce and deliver* the product (goods and services).Operational issues include designing, acquiring, operating, and maintaining the facilities and processes; purchasing raw materials; controlling and maintaining inventories; and providing the proper labor needed to produce a good or service so that customers' expectations are met. This course in operations management is intended to be a survey of operating practices and models in both manufacturing and service oriented firms.

Course Objectives

- Build an understanding of how the Operations Manager fits into the organization.
- Provide a knowledge base for conversing with operations personnel.
- Build both quantitative and qualitative analysis skills, especially those needed for managing operating systems.
- Provide modeling concepts which can be used to help managers evaluate various management problems.
- Show the similarities of operating problems in the Manufacturing and Service Sectors.

MODULE I

1 . Introductions: Concepts in operations planning and concepts for various operational systems in manufacturing and service sectors.

2. Forecasting Techniques: Forecasting as a planning tool, forecasting time horizon, short and long range forecasting, sources of data, types of forecasting, qualitative forecasting techniques, quantitative forecasting models - Linear regression, Moving average, Weighted moving average, Exponential smoothing, Exponential smoothing with trends, Techniques for seasonality cycles, techniques for cycles, Measurement of errors, accuracy and control of forecast.

3. Concepts and quantitative methods in plant location : Need and nature of location decisions, factors affecting location decisions and their relative importance for different types of facilities, Evaluating Location alternatives – break even analysis, transportation model, factor rating, center of gravity method.

MODULE II

4. Concepts and quantitative methods for plant layout: Layout and its objectives, principles, types of plant layouts – product layout, process layout, fixed position layout, cellular manufacturing layouts, hybrid layouts, Factors influencing layout changes.

5. Assembly Line Balancing : Concept of work stations, cycle time, idle time. Assigning task to work station using single rule or combination of rules - task times, following tasks, positional weight.

6. Aggregate Planning and Master Production Scheduling : Purpose and scope, basic strategies of aggregate planning, techniques for aggregate planning. Master scheduling.

MODULE III

7. Inventory Control, MRP and CRP: Dependent and independent demand. Inventory control, EOQ models for purchasing and manufacturing situation with and without shortages, MRP and CRP

8. Sequencing and Scheduling : Scheduling operations, Scheduling in low volume systems-Gantt chart, assignment model. Sequencing, priority rules, single processor system, two processor and multi-processor systems, Johnson's rule , Jackson's rule.

MODULE IV

9. Product mix situations using LP techniques: Formulation of linear programming problem, Simplex method (Analytical & Graphical), Big M method.

10. Project Planning and Control: Network analysis - PERT and CPM, Total slack, free slack, Probability of achieving completion date, Cost analysis, crashing of projects.

Text Books

1. Monks J. G., Operations Management: Theory and Practical McGraw Hill, 1985.
2. William J. Stevenson: Production/operations Management

References:

1. Martin K Starr, Operations Management, Prentice Hall.
2. Vollman Thompson etal, Manufacturing Planning and Control Systems.
3. Fogarty Donald W and Hoffman Thomas R, Production and Inventory
4. Management, South Western Publishing Comp
5. Montgomery D C and Johnson L A Operations Research in Production Planning and Control.

ME 6.7 Practicals In GAS DYNAMICS AND TURBOMACHINERIES

Course Objectives:

- To understand turbmachinery behaviour under constant speed.
- To gain insight into constant head behaviour of turbo-machineries.
- To gain insights into operational ranges, behavioural trends and shortcomings across different compressible and incompressible equipments.

Instructional Objectives:

- To teach students the operation of various energy conversion devices that help students understand the devices used in diverse sectors of energy , process, and manufacturing.
- To help students gain knowledge about compressible and incompressible machineries.

No. of Hours per week :2 hours

Max marks for practicals :25

List of Experiments

1. To study the constant speed (operating) characteristics of Pelton wheel turbine.
2. To study the constant head (main) characteristics of Pelton wheel turbine.
3. To study the constant speed (operating) characteristics of the Kaplan Turbine.
4. To study the constant head (main) characteristics of the Kaplan Turbine.
5. To study the constant speed (operating) characteristics of Centrifugal pump.
6. To study the constant head (main) characteristics of centrifugal pump.
7. To study the operating characteristics of Gear pump at constant speed.
8. To conduct performance test on centrifugal blower.
9. To study the constant speed (operating) characteristics of Reciprocating pump.

M.E.6.8 Practicals in Engineering Measurements and Metrology

Course Objectives: To carry out the experiments to understand and appreciate the application of standards in quality control.

Instructional Objectives: Help the students to lean the principle, construction, operation and application of different measuring instruments used to measure different mechanical quantities.

The Term work should be in the form of Journal consisting of following three sections

No. of Hours per week :2 hours
Max marks for practicals :25

A) Experiments: (Any eight of the following)

1. Measurement of straightness, flatness, roundness.
2. Measurement of the Surface roughness.
3. Measurement of angle by sine bar / Sine center.
4. Measurement of various elements of screw thread using Tools Makers Microscope.
5. Measurement of Screw thread parameters using Floating Carriage Micrometer.
6. Measurement of Gear tooth thickness using Gear tooth Vernier caliper and Span Micrometer.
7. Study and Experiment on Profile Projector.
8. Straightness measurement using Autocollimator
9. Measurement of dimensions using Vernier Height Gauge.
10. Alignment Test on Lathe/ Drilling/Milling Machine
11. Experiment to measure Process Capability using Statistical Process Control.
12. Determining the accuracy of electrical and optical comparator.

B) Experiments (any 3 of the following)

1. Calibration of LVDT
2. Calibration of Piezo electric transducers.
3. Calibration of Strain Gauge
4. Calibration of Load cell
5. Calibration of pressure cell.

6. Calibration of Pyrometers.

C) Assignments

1. Limits, fits and tolerances.
2. Coordinate measuring machine
3. Geometric tolerance.
4. Application of Machine vision in metrology.

M.E. 6.9 Practicals in Mechatronics

Course Objectives:

- To conduct experiments on various transducers to understand their characteristics and their behavior.
- To learn to design pneumatic circuits.
- To gain insight into data acquisition with graphical programming by Lab View software.
- To write programs in assembly language for microcontroller
- To design signal conditioning circuits

Instructional Objectives: To teach students the concepts of various mechatronics devices and conduct experiments on the same.

No. of Hours per week :2 hours

Max marks for practicals :25

List of Experiments

1. Experiment on LVDT trainer

2. Experiment on Strain gauge trainer

3. Experiment on Temperature transducer (Thermocouple)

4. Data acquisition from pressure sensor using LabView

6. Data acquisition from Flow sensor using LabView

7. Data acquisition from temperature sensor using LabView

8. Design of signal conditioning circuits

9. Simple programs in assembly language using 8051 microcontroller

10. Simulation of industrial process control using LabView

11. Exercises on control system using LabView & SIMULINK

12. Experiment on process control trainer

ME 7.1 CAD/CAM

	L+T+P
Lectures/Tutorial/Practical per week	3+1+2
Max. Marks for theory paper	100
Max. Marks for Sessionals	25
Max Marks for Practicals	25
Max Marks for Orals	25
Total number of modules	4
Total number of questions from each module	2
Duration of theory paper	3 hours
Total number of questions to be answered	5 (at least one question from each module)

OBJECTIVES

- To provide an overview of hardware, software, concepts of geometrical modeling & FEM and artificial intelligence in design & manufacturing.
- To introduce the student to the basic fundamentals of Computer Graphics, which can help him to visualize the graphic images/geometric model on the screen.
- To learn the basics of NC, CNC & DNC machine tools & also explain the concepts of NC part programming & computer assisted programming language. Suitable illustrations will enable the student to write his her own programs.
- To provide a glimpse of robot technology & rapid Prototyping.
- To understand the basic concepts of automation in FMS & CIM & how it can be implemented in modern factories.

INSTRUCTIONAL OBJECTIVES

- The student should be able to use the method of geometric construction for solid modeling with CAD softwares like CATIA, SOLIDWORKS, PRO- E etc.
- The student should be able to apply the concepts of FEM in mechanical engineering analysis using softwares like ANSYS, NASTRAN, ABACUS etc.

- Concepts like scan conversion, algorithms for line and circle drawing, clipping & geometric transformations can provide a platform for developing CAD/CAM software.
- The student should be able to write CNC programs independently for any specific CNC machine.
- The concepts of robotics and FMS should prepare the student for further work and research on these topics.

MODULE-I

Fundamentals of CAD/CAM, CIM and automation, CAD/CAM Hardware, CAD/CAM Software, Geometric modeling – Geometric models and construction methods, Finite element analysis procedure, FEM software, Concurrent engineering, CAD standards, Introduction to CAD CAM data exchange.

(14 Hours)

MODULE-II

Interactive computer graphics, 2D & 3D graphics concepts, Raster scan graphics, Line and circle drawing, Scan conversion, real time scan conversion, Run length encoding, Character display, Window clipping, Geometric transformations, Visible line and visible surfaces, Elementary 2D Computer graphics algorithms, Computer animation in Engineering – Animation types.

(12 Hours)

MODULE – III

Numerical control, N.C. part programming, Computer aided part programming, APT language, Computer controls in NC, Adaptive control, Robot technology, Programming & applications, Rapid Prototyping, RP processes, Design modeling for RP- The STL file, The SLC format, Introduction to reverse engineering.

(12 Hours)

MODULE – IV

CAPP, Automated material handling and storage systems, FMS, Automated inspection and testing, Web based design & Manufacturing, Artificial intelligence in design & manufacturing, Components, hardware elements & interfaces of networking in CIM, OSI model for Network communication, MAP, Group Technology.

(12 Hours)

TEXT BOOKS

1. P.N. Rao – CAD/CAM Principals & applications ___ Tata McGraw Hill (TWH)
2. Mikell P. Groover – Automation, Production Systems & Computer Integrated Manufacturing --- Pearsen Education Asia.
3. Ibrahim Zeid _ CAD/CAM Theory & Practice – (TMH)
4. David F. Rogers – Procedural elements for computer graphics --- (TMH)

REFERENCES:-

1. Mikell P. Groover – Emory W Zimmers Jr. –CAD/CAM --- Prentice Hall of India.
2. Amitabha Ghosh – Rapid prototyping --- Affiliated East West press Pvt. Ltd.
3. N. Krishnamurthy- Introduction to computer graphics --- (TMH)
4. C.S. Krishnamoorthy, S. Rajeev – Computer Aided Design Software & Analytical Tools --- Narosa Publishing House.
5. T.K. Kundra, P. N. Rao, N.K. Tewari – Numerical control & computer aided manufacturing --- (TMH)
6. Schaum's outline series – Computer graphics --- (TMH)
7. William M. Newman, Robert F. Sproull – Principles of Interactive computer Graphics --- (TMH)
8. Donald Hearn, M. Pauline Baker – Computer Graphics --- Prentice Hall of India.
9. Radhakrishnan P. Subramanyan S, CAD/CAM/CIM, New Age International publishers, 1994
10. Tien Chien Chang, Rolland Wyst, HSU Pin Wang, Computer aided manufacturing, Pearson Education

ME 7. 2: REFRIGERATION AND AIR CONDITIONING

	L.T.P
Lectures/Tutorial/Practical per week:	3+1+2
Max. marks for theory paper:	100
Max. marks for sessionals	25
Max. marks for orals	25
Max for Practical	25
Total No. of questions from each module	2
Total No. of questions to be answered	5 (At least one question from each module)

Course Objectives

This is an core course of mechanical engineering with knowledge drawn froThermodynamics, heat and mass transfer and fluid mechanics. Application of this knowledge will lead engineers to design and improve HVAC industry.

Instructional Objective

1. To introduce various aspects of refrigeration and Air conditioning under heating ventilation and Air-conditioning (HVAC)
2. To give gasic knowledge of various thermodynamic cycles and methodologies of refrigeration and Air Conditioning.
3. To introduce refrigeration load calculations and selection of components. To design refrigeration & Air conditioning equipments.

MODULE I

(10+3)

1.1 Introduction

Methods of Refrigeration: Ice refrigeration, dry ice refrigeration, evaporative cooling, refrigeration by expansion of air, refrigeration by throtting of gas, steam jet refrigeration system, thermoelectric cooling, vortex tube refrigeration (descriptive treatment only).

Application: Applications of Refrigeration – Food preservation and distribution, Chemical and process industries, Cryogenics, Applications of Air- conditioning Industrial, such as in textiles, printing, manufacturing, photographic, computer rooms, power plants, vehicular, Comfort – commercial, residential. Hospitols computer, pharma Industry.

1.2 Air refrigeration system

Defination, refrigeration load, unit of refrigeration, reverse Carnot cycle Bell-Coleman cycle(problems), methods of air refrigeration systems, second law analysis, aircraft refrigeration systems such as simple air cooling system, boot-strap system, reduced ambient system, regenerative system, Numerical and solution procedure.

MODULE II

(12+3)

2.1 Vapour Compression System

Limitations of air refrigeration system, development of vapour compression cycle (VCC), use of p-h charts, Second Law Analysis, actual vapour compression cycle. Introduction to multistage compression systems Two stage compression with flash gas removal, liquid intercooler, flash cooling, flash sub-cooling. Introduction to CASCAD refrigeration system, Numericals and solution procedure.

2.2 Vapour absorption system

Introduction, simple vapour absorption system, practical vapour absorption system, COP of an ideal vapour absorption mixture, water ammonia system(problems), Electrolux refrigerator, lithium bromide absorption system(descriptive treatment only)

MODULE III

(11+2)

3.1 Refrigerants and Components of refrigeration and air conditioning system

Desirable properties of refrigerants classification of refrigeration, secondary refrigerants, alternative refrigerants for CFC's and HCFC's ozone depletion potential (ODP) Global warming potential (GWP) total equivalent warming impact (TEWI), Montreal protocol, Kyoto protocol, Clean Development Mechanism.

Compressors, condensers, evaporators, expansion devices such as capillary tubes, automatic expansion valves, thermostatic expansion valves, Condensing Units and Cooling Towers, Pressure and Temperature controls. (Descriptive treatment only)

3.2 Psychrometry

Introduction, Psychrometry terms,use of Psychrometric chart, Psychrometric processes, adiabatic saturation temp. Evaporative cooling, bypass factor of coil, efficiency of coil, Air washers, Thermodynamics of human body with environment, effective t4empcomfort chart.

MODULE IV

(12+4)

4.1 Air Conditioning and Selection of air- conditioning Systems

Defination, factors, equipment used, classifications, all air system, all water air water system, unitary and central air conditioning systems, auditorium air conditioning system, Numericals on air conditioning systems using Psychrometric chart.Introduction to thermal distribution systems and their function, Selection criteria for air- conditioning systems. (Elementary treatment only)

4.2 Cooling and Heating Load Calculations

Introduction, Heating Vs cooling load calculations, Methods of estimation of heating and cooling loads, External loads, Internal Loads, Characterization of Sensible and latent heat loads – Need for Ventilation, Consideration of Infiltration – Load concepts of RSHF, GSHF-Problems,Concept of ESHF and ADP.

TEXT BOOKS

1. Refrigeration and Air conditioning – C. P. Arrora – Tata Mc Graw Hill Co. New Delhi
2. Refrigeration and Air conditioning – Arora S. C. & Domkundwar S. Dhapatrai & Sons, New Delhi.

REFERENCES:-

1. Refrigeration and Air conditioning - Manohar Prasad. Wiley Eastern Limited
2. Refrigeration and Air conditioning – Anantanrayanan, Tata Mc Graw Hills Co. New Delhi
3. Refrigeration and Air conditioning – Dossat Ray J. Wiley Eastern Limited.

REFRIGERATION AND CONDITIONONG LABORATORY

Practical hours per week: 2

Maximum Marks for Practical Examination : 25

The term work shall consist of minimum five experiments from the following:

List of Practicals

1. Performance test on vapour compression test rig.
2. Performance test on air conditioning test rig.
3. Performance test on ice plant test rig.
4. Performance test on Heat Pump Trainer
5. Study of compressiors
6. Study of vapour absorption / Electrolux system
7. Determinations of cooling load of air conditioning system (case study)
8. Study of installation / operation / maintenance practices for refrigeration systems
9. Visit to any refrigeration or air conditioning plant.

TEXT BOOKS

1. Refrigeration and Air conditioning – Arora S. C. & Domkundwar S., Dhanpatrai & Sons, New Delhi.

REFERENCEBOOKS:-

1. Refrigeration and Air conditioning – C. P. Arora S. C. & Domkundwar S., Dhanpatri & Sons, New Delhi
2. Refrigeration and Air conditioning – Manohar Prasad, Wiley Eastern Limited
3. Refrigeration and Air conditioning-Anantanrayan, Tata McGraw Hills Co.,New Delhi
4. Refrigeration and Air conditioning – Dossat Ray J, Wiley Eastern Limited.

ME 7. 3 MANUFACTURING TECHNOLOGY III

	L T P
Lectures/Tutorial/Practical per week:	3+1+0
Max. marks for theory paper:	100
Max. marks for sessionals	25
Total No. of questions from each module	2
Total No. of questions to be answered	5 (At least one question from each module)

Course Objectives: This course will enable the students to understand the following:-

- Press working operations, classifications, classification of dies and presses, theory of cutting bending and drawing.
- The fundamentals of jigs and fixtures
- Elements of plane milling cutter, design aspects of twist drill, selection of grinding wheel and theory of form tool design.
- Broach tool design, surface finishing processes, powder metallurgy,wear mechanism and machinability of some metals.

Instructional Objective:- This course provides a comprehensive knowledge and insight into the press working operations with emphasis on classification of dies and presses. Sheet metal working to be covered with particular emphasis on bending drawing and cutting. Jigs and fixtures are required to be covered in depth. The course is further directed towards milling cutters, twist drills and grinding wheels. Due stress is required to be given to broach tool design, surface finishing processes and powder metallurgy. Finally wear mechanisum and machinability of some metals is required to be covered.

MODULE I (12)

a) Sheet metal working: Introduction, standards die set and its accessories.
b) Press working operation: Shearing, blanking, punching and piercing, notching and semi-notching, slotting, trimming, bending and drawing, embossing.
c) Types of dies: simple, compound, combination , progressive and transfer. Stock layout techniques.
d) Selection and classification of presses
e) Theory of cutting, clearance,force calculations
f) Bending: V, U and edge bending, developed length calculations, bending forces
g) Drawing: Theory of drawing, shell blank calculations.

MODULE II (12)

Jigs and fixture: Introduction, definitions,elements, presentation of workpiece in a jig/fixture drawing. Types of locaters, clamps, jig bushes, standard jigs and fixtures for turning, milling and grinding. Design principales of location, clamping for jigs and fixtures. Design of jigs/fixtures for simple components

MODULE III (12)

a) Form tool design
b) Milling cutters and its classification, elements of plain milling cutter, influence of tooth angles on cutter performance.
c) Broach tool design, theory of broaching.
d) Twist drill geometry and its design aspects.
e) Grinding wheel nomenclature, selection of grinding wheel.

MODULE IV

a) Surface finishing processes: lapping, honing, super finishing and burnishing.
b) Powder metallurgy: manufacturing of metal powders, mixing and blending Compacting, sintering and secondary operations. Advantages, limitations and applications of powder metallurgy. Recent trends in powder metallurgy.

c) Wear mechanisms of H. SS and carbide tools.
d) Machinability of magnesium, aluminum, copper, iron and steel.

TEXT BOOKS

1. Eary and Reid- Techniques of pressworking sheet metal-Prentice Hall Inc.
2. Joshi P.H. – Jigs and fixtures-TMH
3. Arsihnov-Tool Design MIR Publication.
4. ASTME- Tool Design
5. Trent E.M. – Metal Cutting – Butterworths.

REFERENCEBOOKS:-

1. HMT – Production Technology.
2. Kempster – Introduction to jigs and fixtures – ELBS
3. Juneja B.L. and Sekhon G. S. – Fundamentals of metal maching and machine tools Wiley Eastern LTD.
4. Donaldson – Tool Design.

ME 7. 4. 1: ADVANCED MECHANICS OF SOLIDS

	L.T.P
Lectures/tutorial/Practical per wkeek:	3+1+2
Max. mars for theory paper:	100
Max. marks for sessionals:	25
Max. marks for orals:	25
Total No. of questions from each module:	2
Total No. of questions to be answered;	5 (At least one question from each module)

MODULE I (12+4)

Analysis of stress: Analysis of stress and Strain, tensor notation, Transformation equation for stress, Principal stresses, octahedral stresses, Mohr's circle.

Analysis of strain: Definition, displacement field, strain as second order tensor, Principal strains, Compatibility equations.

MODULEII (12+4)

Theory of elasticity: Constitutive equations, equations of elasticity, uniqueness, superposition and St. Venant's principal, Airy's stress function. Two-dimensional problems in Cartesian co-ordinate system, bending of narrow cantilever beam of narrow cross section under edge load and simply supported beam of narrow cross section under edge load and simply supported beam subjected to uniformly distributed load.

MODULEIII (12+4)

Axi-symmetric problems: General equations in cylindrical co-ordinates, Thick cylinders under uniform pressure, shrink and force fit, stresses in rotating discs.

Torsion: Torsion of circular and non-circular bars, torsion of thin tubes.

MODULEIV **(12+4)**

Energy Methods: Maxwell-Betti's Reciprocal theorem, Castigliano's theorems, principal of virtual work.

Elastic stability: Bucking of columns, Rayleigh-Ritz method to find critical load for columns.

Recommended books

1) Advanced Mechanics of solids- L. S. Srinath.
2) Introduction of solid Machins – Irvin Shames
3) Solid Mechanics - S.M.A. Kazimmi
4) Elementry Mechanics of solid - Singh & Jha

ME 7. 4. 2 TOOL ENGINEERING AND DESIGN

	L.T.P
Lectures/Tutorials/Practicals per week:	3+1+2
Max. marks for theory paper:	100
Max. marks for sessionals	25
Max. marks for orals	25
Total No. of questions from each module	2
Total No. of questions to be answered	5 (At least one question from each module)

Course Objective: To prepare mechanical Engineer to be specialised in Tool Design aspects of various types of tools required in various machine processes and various types of form tools.

Instructional Objectives: The study of various types of tools required for machinery processes and forming tools including plastic tooling, and tools required for N C Machine tools should be dealt in detail, give brief about processes before giving to design aspects.

MODULE 1 **(06 Hrs)**

1. **Tool Design Method and Tool Materials**: Introduction, the design procedure, properties of cutting tool material. Ferrous tooling materials such as Tool steels cast iron, Mild or low carbon steels. Nonmetallic, Non Ferrous tooling materials. Heat treating. Factors effecting heat treating. Heat treatment and tool design.

(06 Hrs)

2. **Design of Single Point Cutting Tools:** Basic requirement of cutting tools. Single point tools. Tools nomenclature, geometry of single point cutting tool, design of shank dimension using strength and rigidity consideration and selection of geometry for the cutting tool point. Boring tool, types of boring tools. Boring – bar and cutting adjustment. Design features of shaper. Planner, and slotter tools. Selection of carbide cutting tools. Determining shank size for single point carbide tools Determining the insert thickness for carbide tools.

MODULE II **(06 Hrs)**

3. **Design of Drill:** Geometry of drill, type of drill, effect of various factor on axial thrust and torque in drilling. Design of basic element of drill. Problem on drill body and flute of drills and selection of geometry**.**

(06 Hrs)

4. **Design of Milling Cutters:** profile sharpened milling cutters, profile sharpened plain milling cutters, profile sharpened face-milling cutter, profile sharpened side milling cutter, circulars saws, profile sharpened end- milling cutter, profile sharpened form milling cutter, and form relieved milling cutter. Design problems.

MODULE III **(6 Hrs)**

5. **Design of Form Tools:** Form tools for turning application, Flat form tools, Graphical profiling of flat form tools, Circular form tools, Correction of angles, Correction of Circular arcs, Comatibility of Tool angles, Tangential form tool.

(06 Hrs)

6. Type of form milling cutters, Design of the flank surface, Relieving along ogarithmic spiral, Archimedean spiral and Straight line.Form RelievinClearance of relief angle at various radii, Angular relieving, Design of relieving, Design considerations for disc-type gear milling cutter, Design procedure for disc-type cutter and End-mill type gear milling cutter.

MODULE IV **(6 Hrs)**

7. **Using Plastic as Tooling Material**: Introduction, plastic is commonly used as tooling materials , application Epoxy plastic tools, construction methods of plastic tooling, metal forming operations with Urethane Dies. Calculation of force for Urethane pressure pads. Design of Urethane dies for simple components.

(6 Hrs)

8. **Tool Design for Numerically Controlled Machine Tools:** The need for numerical control, Numerical control system, Fixture Design for numerically controlled machine tools, Cutting tools and tool holding method for numerical control, Automatic tool changes and tool positions, tool presetting.

Text Books

1. C. Donaldson. G. II. LeCAIN. And V.C. GOOI.D. “Tool Design” Edn 1976. Ch. 1,2,6&7. Tata MeGraw Hill Pub.
2. Nagpal. “Tools engineering and design” Khanna Pub. Edn. 1998. Ch. 1.2.6.&7
3. ASTME “Fundamental of tool design” Edn 1979. Ch. 7. Prenticle Hall India.
4. P.N.Rao. “ Manufacturing technology (Foundry Forming and Welding)” Edn 1996. Dieeasting Dochler. TATA Me GRAW HILL Publication.
5. Metal Cutting Theory and Practice by A. Bhattacharya, Central book publisher, Calcutta, India, Revised and Enlarged Edition, April 1984.

Ref. Books

1. V. Arshinov & G. Alkeseev, Metal Cutting Theory & Cutting Design. 1976 Ch. 2.3.4.&5. Mir Pub. Mascow Edn.

2. N. Nefdov. R. Osipov. Typical example & problems in metal ullium theory & cutting tool design” & dn 1987. Ch. 2.3.4.&5 MIR Publishers

3. Duminck V. Rosalto Dmold V. Rosalto

ME 7. 4. 3 CRYOGENICS

	L T P
Number of Lectures/Tutorials/Practicals per week	**3+1+2**
Question paper Duration	**3 Hrs**
Maximum Sessional Marks	**25**
Maximum oral Marks	**25**
Maximum Marks (theory)	**100**
No. of question for each module	**02**
Total number of questions to be answered	5 (at least one question from each module)

Course Objectives:

Use the information described in the course description to properly model and design very low temperature (cryogenics) systems.

Instructional Objective:

1. To build a solid foundation in the fundamentals of cryogenics
2. To encourage a "hands-on" approach to solving cryogenic problems
3. To define and demonstrate " what's different" at low temperatures
4. To provide up-to-date cryogenic solution of open-ended, client-based design problems.

MODULE I

(12+4)

Introduction : - Historical review, application areas, Temperature and temperature scales. First, Second and Third laws of Thermodynamics. Properties of state. Reversible and irreversible process. Heat engines and phase transitions. Review of solid and fluid properties at low temperatures

MODULE II

(12+4)

Liquefaction systems: Liquefaction Open and closed cycles; Effect of Component efficiencies as performance; Simulation of performance of different cycles

Cryogenic Refrigerators: Recuperative and Regenerative cycles – Effect of Irreversibility on system performanc

MODULE III

(12+4)

Micro-miniature cryocoolers for space and defence applications

Design criteria for equipment associated with low temperature systems: heat exchangers, compressors,expanders.

MODULE IV

(12+4)

Separation and purification systems, commercial air separation cycles

Industrial Storage and Transfer of Cryogens – Safely and handing of cryogens, cryogenic insulation.

Text Books

1. Barron, R. F., Cryogenic Systems, Oxford University Press, New York, 1985.

2. Timmerhaus, K. D., and Flynn, T. M., Cryogenic Process Engineering, Plenum

Press, 1989.

Reference Books

1. Haseldon, G., Cruogenic Fundamental, Academic Press.

ME 7. 4. 4 ENGINEERING TRIBOLOGY

	L T P
Number of Lectures/Tutorials/Practicals per week	3+1+2
Question paper Duration	3 Hrs
Maximum Sessional Marks	25
Maximum oral Marks	25
Maximum Marks for Theory	100
No. of question for each module	02
Total number of questions to be answered	5 (at least one question from each module)

Course Objectives: This is an interdisciplinary course with knowledge drawn from different disciplines of mechanical engineering, materials science, chemistry and physics. The interaction between these different fields will lead engineers to control wear and friction.

Instructional Objective: Tribology focuses on friction, wear and lubrication of interacting surfaces in relative motion. Tribological studies have economic benefits in improving reliability, ensuring maintenance and reducing wear.

MODULE I

Introduction: Meaning of Tribology, Lubrication and wear. (2)

Physical Properties of Lubricants: Oil viscosity & Viscosity Index, Viscosity Measurements, Viscosity of Mixtures, Oil Viscosity Classification, Thermal Properties of Lubricants, Lubricant impurities and Contaminants. (3)

Hydrostatic bearings: Hydrostatic Bearing Analysis, Flat circular Hydrostatic Bearing: Pressure Distribution, Lubricant Flow, Load Capacity, Friction Torque, Friction Power Loss, Generalized Approach to Hydrostatic Bearing (5)

MODULE –II

The Friction of Solids: Genesis of Solid Friction: physical basis of the laws of Friction, Adhesion, Junction Growth. Static and Kinetic Friction: Stick-Slip Effects & Measurement of Friction. Friction of Non Metallic Materials, Tribo-Monitoring of Friction,

(5)

Wear & surface damage: Introduction, Classification of Wear, Wear Maps Mechanism of Wear: Seizure, Melt wear, Oxidation Dominated Wear, Mechanical Wear Process, Running in Adhesive Wear, Abrasive Wear, Delamination Wear, Fatigue Wear in Rolling Contacts, Fretting and Corrosive wear, Erosive Wear, Third bodies & Wear: Interfacial Third Bodies, Debris Analysis. Tribo-Monitoring

(5)

MODULE – III

Hydrodynamic Bearings: Introduction, Reynolds Equation, Simplifying Assumptions, Equilibrium of an Element, Continuity of flow in a Column, Simplifications of Reynolds Equation, Bearing Parameters predicted from Reynolds Equation. Pad bearings: Infinite Liner Pad Bearings, Infinite Raylegih Step Bearing, Finite Pad Bearings,Pivoted Pad bearings. Converging Diverging Wedges: Bearing Geometry, Pressure Distribution, Load Capacity. Journal Bearings: Evaluation of Main Parameters, Practical and Operation aspects of Journal bearings.

(9)

Aerostatic bearings: Pressure Distribution, Gas flow, Load Capacity, Friction Torque and Power loss. Hybrid Bearings, Stability of Aerostatic Bearings.

(2)

MODULE – IV

Elastohydrodynamic Lubrication: Introduction, Contact Stresses, Contact between varying elastic bodies with varied geometry, Contact Area, Pressure, Maximum Deflection, and Position of Maximum Shear Stress. Elastohydrodynamic Films. Effects contributing to the generation of Elastohydrodynamic films. (6)

Types of bearing oil pads: Hydrostatic Bearing, Wick oiled Bearings, Oil rings, rings, Pressure feed bearings, Partial bearings, Externally Pressurized Bearings.

(5)

Bearing Materials: General requirements of bearing materials, types of bearing materials. (3)

TEXT BOOKS

1. S.K. Basu, S.N. Sengupta, B.B.Ahuja, Fundamentals of Tribology, Prentice Hall of India.

2. S.K. Srvatsava, Tribology in Industry, S Chand & Co.

REFERENCE BOOKS:

1. G.W. Stachowiak, A. W. Batchelor, Engineering Tribology, Butterworth-Heinemann.

2. Mechanical Engineering Handbook by Higgins

ME 7.4.5 MANAGEMENT INFORMATION SYSTEMS

	L T P
Lectures per week:	3+1+2
Max. marks for theory paper	100
Max marks for sessionals	25
Max marks for orals	25
Total No. of questions from each module	2
Total No. of questions to be answered	5 (At least one question from each Module.)

This course is aimed at providing an understanding of the concepts of management information system, Decision Making, Information, Databases, Database Management Systems and tools and methodologies for structural analysis and design of information systems and other related concepts. The students are expected to acquire competence in design of MIS in various functional areas of Management through case discussions and Project Assignments.

MODULE I **(12+4)**

Introduction of Information Systems, Distinction between Data & Information, Growth of Hardware. Classification of hardware and software. Basics of networking topology. Basics and discussion of internet, internet and extranet. Discussion of the domain name classification systems in Internet.

Different storage media, Different file storages, different file organizations – sequential, hashed, indexed, file organizations to support multi-attribute search. Different database structures-hierarchical, network, relational and object oriented.

MODULE II **(12+4)**

Concepts of decision making – Simons model of decision making, decision making under certainty, risk and uncertainty, Maxinin and minimax criteria, payoff matrices, decision trees, utiles, ranking, weighing and elimination of aspects.

Concepts of System-classification, Coupling and decoupling, Negative entropy, handling of system stress.

Concepts of Data & information-Value of Information, Value of perfect information, Data Independence – Physical and logical. Data dictionary.

MODULE III (12+4)

Logocal & Physical modeling of Data. Data Flow Diagrams – context diagrams and leveling

Tools for analysis and modeling of process – Flow charts, structured English, pseudocode, Decision Tables, LEDT & EEDT, Karnaugh Maps.

Concepts of databases, Graphical tools in logical modeling – Entity Relationship Diagrams (ER diagrams)

Introduction to Gnu/Linux O.S., Comparison free and open source software with proprietary software.

Relational Database Management Systems (RDBMS)); Data Defination, Data Manipulation and Query – Structured Query Language (SQL). Relating between tables. Comparison of popular RDBMS packages.

MODULE IV (12+4)

Semi structured problems and decision support systems.

Expert Systems – basics classification and development. Evolution of MIS in an organization – Nolan's stage model. MIS development – life cycle and prototype approach. Information system audit Long term MIS planning.

TEXT BOOKS

1. Management Information systems-Gorden and Margrethe Olsen, Tata McGraw Hill. New Delhi.
2. Analysis and Design of Information Systems – V. Rajaramn. Prentice Hall India Ltd.
3. Management Information Systems – Parkar and case, McGraw Hill International.

REFERENCE :

1. **HTTP:// WWW/GNU.ORG – Concepts of free software and Gnu/Linux OS**
2. **HTTP://WWW.POSTGRESQL.ORG – PostgreSQL tutorial**

M.E. 7.4.6 6- Sigma Management

L T P

Lectures/Tutorials/Practical per week: **3+1+2**

Max marks for theory paper: **100**

Max. marks for sessionals **25**

Max. marks for orals: **25**

Total no. of questions from each module: **2**

Total no of question to be answered: **5 (At 1east one question from each module.)**

Course Objectives:

The primary objectives of this course is exposing students to the fundamentals of Six Sigma methodology, tools and techniques, and building in confidence and capability amongst students in mapping the organizational activities and problems in terms of Six Sigma framework,

Instructional Objectives:

The course will address the following main issues:

i) Introduction of Six-sigma

ii) Tools used in Six-sigma.

iii) QFD, FMEA, DOE and Taguchi Methods

iv) DMAIC and DFSS process

MODULE I

(12+4)

Overview of Six Sigma Management

Successful applications of Six Sigma Management, Timeline for Six Sigma Management, Benefits of Six Sigma Management, Voice of the Process, Voice of the Customer, Definitions(Non-technical and Technical) of Six Sigma.

Six Sigma Roles, Responsibilities: Champion, Master Black Belt, Black Belt, Green Belt, Process Owner. Terminologies in Six Sigma Management.

Tools used in Six Sigma

Frequency distribution and Histogram, Run charts, Stem-and-leaf plots, Pareto diagrams, Cause and Effect Diagrams, Box Plots, Normal probability plots.

Measures of Central Tendency, Measures of Variation.

MODULE II

(12+4)

Techniques used in Six Sigma: (At least two case studies each to understand concepts)

Quality Function Deployment (QFD) Failure Mode and Effects Analysis (FMEA).

MODULE III

(12+4)

Techniques used in Six Sigma: (At least two case studies each to understand concepts)

Design of Experiments (DOE): Factorial designs: Introduction, Two-Factor factorial design, ANOVA. 2^k Factorial Design: 2^2 and 2^3 designs only, ANOVA.

Taguchi Method:

Taguchi philosophy, Loss functions, Signal-to-Noise ratio, experimental design in Taguchi Method, Parameter design.

MODULE IV

(12+4)

DMAIC process

Define, Measure, Analyze, Improve, Control. *(At least one case study each from manufacturing industry and service industry)*

Design for Six Sigma (DFSS)

Need for DFSS. Introduction, Define, Measure, Analyze, Design, Verify, *(At with at least two case studies).*

Texts

1. Gitlow H. S. and Levine D. M., Six Sigma for Green Belts and Champions, Pearson Education.
2. Mitra A., Fundamentals of Quality Control and Improvement, Pearson Education.
3. Montgomery D. C., Design and Analysis of Experiments, John Wiley & Sons (ASIA)
4. Ross P. J., Taguchi techniques for Quality Engineering, McGraw Hill

References

1. McCarty T, Daniels L., Bremer M., Gupta P., The Six Sigma Black Belt Handbook, McGraw Hill.
2. Allen T., Introduction to Engineering Statistics and Six Sigma, Springer London.
3. ReVelle J., Moran J., Cox C., The QFD Handbook, John Wiley and Sons.

ME 7. 4. 7 ANALYSIS & SYNTHESIS OF MECHANISMS

L T P

Lectures/Tutorials/Practical per week: 3+1+2

Max marks for theory paper: 100

Max. marks for sessionals 25

Max. marks for orals: 25

Total no. of questions from each module: 2

Total no of question to be answered: 5 (At 1east one question from each module.)

MODULE I **(12+4)**

1.1 Review of the Basics of Kinematics.

1.2 Kinematic Analysis of Plane Mechanisms: Displacement, Velocity and acceleration analysis of simple and complex mechanisms by analytical and graphical methods.

MODULE II **(12+4)**

Curvature theory: Fixed and moving centrodes, envelops – velocity and acceleration inflection points and inflection circle. Euler – Savary equation, Bobillier's theorem, Hartmans's construction, return circle, cusp points, cubic of stationary curvature, Ball's point, Application in dwell mechanisms.

MODULE III **(12+4)**

Kinematic synthesis of plane mechanisms: Type, number and dimensional synthesis, branch and order defects, Function generation and path generation, rigid body guidance. Chebychev spacing, three, four and five position synthesis, Burmerster point theory, synthesis by analytical methods.

MODULE IV **(12+4)**

4.1 Computer – aided kinematic analysis of planar mechanisms.

4.2 Spatial Mechanisms: Position, velocity and acceleration analysis of RGGR mechanisms, Eulerian angles theorm on angular velocities and acceleration, DH parameters, DH matrix method, application of spatial mechanisms in robotics, Kinematic analysis of industrial robots.

Books Recommended:

1) Theory of Machines and Mechanisms, Shigley & Uicker.
2) Mechanism Design-Analysis and synthesis, Erdman And Sendor.
3) Theory of Mechanisms and Machines, Ghosh & Malik
4) Kinematic & linkage Design, Hall
5) Kinematic synthesis of Linkages, Hartenberg & Denavit.
6) Machines & Mechanisms, Myszka.
7) Computer – Aided Analysis of Mechanical systems, Nikravesh

ME 7. 4. 8 ARTIFICIAL INTELLIGENCE

Lectures per week:	3+1+2
Max. marks for theory paper:	100
Max. marks for sessionals	25
Max. marks for orals	25
Total No. of questions from each module	2
Total No. of questions to be answered	5 (At least one question from each module)

Course Objective:

The purpose of this course is to give students an understanding of Artificial Intelligence methodologies, techniques, tools and results. Students will learn the theoretical and conceptual components of this discipline and firm up their understanding by using AI and Expert System tools in assignments. Interactions between Artificial Intelligence and various Mechanical Engineering disciplines will be explored through assignments.

Instructional Objectives:

At the end of attending this course students should be able to:

1. Represent the knowledge in various forms such as, predicate logic, symbolic representation etc.
2. Exploit this knowledge to derive conclusive outputs.
3. Assimilate this knowledge and store it for being used as expert systems.
4. Use Artificial Intelligence technique in mechanical engineering applications.

MODULE I

1. Overview of history and goals of AI: (03)
   Tentative definitions. Turing's test. Knowledge vs. Symbolic Level. Relations with other disciplines, from Philosophy, to Linguistics, to Engineering. Review of AI successes and failures.

2. State Spaces, Production Systems, and Search: (06)
   State Space representation of problems. Problem solving as search. Constraints. Definition and examples of Production Systems. Heuristic search techniques. Two person games.

3. Heuristic Search Techniques: Generate-and- Test, Hill Climbing, Best-First Search, Problem Reduction, Constraint Satisfaction, Means-Ends Analysis. (03)

MODULE II

4. Knowledge Representation:- Knowledge Representation issues, Representations and Mappings, Approaches to knowledge Representation, Issues in Knowledge Representation.
(04)

5. Using Predicate Logic:- Representing Instance and Isa Relationships, Computable Functions and Predicates, Resolution, Natural Deduction, semantic networks and frames.
(04)

MODULE III

6. Game playing with min-max search, adding alpha beta cut offs. (04)

7. Planning an example domain, the blocks world, components of a planning system, goal stack planning, non linear planning, hierarchical planning (04)

8. Natural language processing: Introduction, syntactic, semantic, discourse and pragmatic processing. (04)

MODULE IV

9. Learning: Definition, rote learning, learning by taking advice, learning in problem solving, learning from examples. (04)

10. Expert system: definition, components, expert system shell, application, knowledge acquisition.
(04)

8. Introduction to Artificial Neural Networks: History and development of ANN, ANN topology. Basic learning laws, supervised and unsupervised learning, stability and convergence, perceptron learning, three layered perceptron, back propagation learning.

(08)

Text Books

1. Luger, Artificial Intelligence
2. Rich & Knight, "Artificial Intelligence".

Reference Books

1. Russell, Norving, Artificial Intelligence, A Modern Approach, Pearson Education..
2. Char nick "Introduction to Artificial Intelligence", Addision Wesley.
3. Marcellous, "Expert Systems Programming", PHI.
4. Elamie, "artificial Intelligence", Academic Press.
   Yegnarayana, Artificial Neural Networks

ME 7. 5. 2 ADVANCED MATERIALS TECHNOLOGY

	L T P
Number of Lectures per week	3+1+2
Question paper Duration	3 Hrs
Maximum Sessional Marks	25
Maximum oral Marks	25
Maximum Marks	100
No. of question for each module	02
Total number of questions to be answered	5 (at least one question from each module)

Course Objectives:

- To introduce the various aspects of Advanced Materials and their applications.
- Distinguish various classes of advanced materials.

Instructional Objectives

- Identify various classes of polymers, ceramics, composite materials, shape memory alloys, their properties and applications.
- Gain an understanding of the sizes involved with Nanoscience & Technology
- Expand the ability to think critically about new technologies and developments.

Module I **(12+4)**

1. **Polymeric Materials:** Introduction, classification, functionality, method of linking, types and properties; Polymerisation techniques – bulk, solution, suspension and emulsion polymerization; Processing of Polymers: Various moulding and casting techniques, calendaring, lamination etc.

2. **Ceramic Materials:** Introduction, classification, structure, properties, processing and applications of ceramic materials

Module II **(12+4)**

3. **Introduction to Composites**
   Basic definitions, various types of composites, Classification based on Matrix Material: Polymer matrix composites (PMC), Carbon matrix Composites Metal matrix composites (MMC), Ceramic matrix composites(CMC): Classification based on reinforcements: Fiber

reinforced Composites, Fiber Reinforced Polymer(FRP) composites, Laminar composites, Particulate Composites, Comparison with Metals, Advantages & limitations of Composits.

4. **Basic constituents materials in Composites and Interfaces:**
   Types of Reinforcements/fibers: Role and selection or reinforcement material, Types of fibres, Glass fibers, Carbon fibers, Armid fibers, Metal fibers, Alumina fibers, Boron Fibers, Silicon carbide fibers, Quartz and silica fibers, Multiphase fibers, Whiskers, Flakes etc., Mechanical properties of fibers.
   Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc.
   Interfaces: Wettability, Interactions at the interface, types of bonding at the interface, tests for measuring the interfacial strength.

Module III

(12+4)

5. Processing of Composite Materials
   Processing of MMC: Solid state, Liquid state, deposition and Instu methods
   Processing of CMC: Conventional mixing and pressing. Techniques involving slurries, Liquid state, sol-gel, vapour deposition Lanxide and Insitu Techniques
   Processing of PMC: Hand lay-up and spray-up, filament winding, pultrusion, resin transfer moulding, SMC and compression moulding.

6. **Applications of composites:** Functional requirements and applications of composites in automotive, aerospace, sports and other engineering fields

Module IV **(12+4)**

7. **Smart materials:** Overview of Smart Materials and Structures, Physical Properties, Piezoelectric Materials, Electrostrictive Materials, Magnetostrictive Materials Magnetoelectric Materials, Magnetorheological fluids, Electrorheological Fluids and Shape Memory Materials.
8. **Nanomaterials:** Overview of nanoscience, Theory, definition and history – Properties at nanoscale, Societal implications of nanoscience – nanotoxicology Materials, structure, nanosurface, Energy at nanoscale, OD, ID,2D and 3D nanomaterials, Carbon based nanomaterials.
   Synthes of Nanomaterials : “Top-down” approach, “Bottom up” approach, Structure and properties; Characterization of nanomaterials: Diffraction techniques, spectroscopy and modeling, Imaging techniques.

Text Books

1) A text book of Polymers – M.S. Bhatnagar-S.Chand & Co., New Delhi

2) Fundamentals of Ceramics – Michel Darsoum, McGraw Hill, NY
3) Composite Materials – F.L.Mathews and R.D. Rawlings, CRC Press, Woodhead Publishing LTD
4) Composite Materials- F.L. Mathews and R.D. Rawlings, CRC Press, Woodhead Publishing LTD
5) Nano Materials- A.K. Bandyopadhyay, New Age Publishers.

References

1. Principles of Polymer Processing – Zehev Tadmor & Costas G. Gogov, Wiley International
2. Handbook of Ceramics, Glasses and Diamonds- Charles a. Harper, McGraw Hill
3. Introduction to Nanotechnology – Charles P. Poole Jr. and Franks. J. Qwens
4. Springer Handbook of Nanotechnology-Bharat Bhusan

ME 7. 5. 3 RAPID PROTOTYPING

	L T P
Number of Lectures per week	3+1+2
Maximum Marks	100
Maximum Sessional Marks	25
Maximum oral Marks	25
No. of question for each module	02
Total number of questions to be answered	5 (at least one question from each module

Course Objectives:

- To introduce students to the latest state of the art prototyping technique called as rapid prototyping.
- To provide insights in to various processes and tooling methods in RP
- To provide an overview the software's and design methodology of RP
- To introduce to the concepts of reverse engineering

Instructional Objectives:

- The concepts learnt should help the student to indentify the merits. Demerits, materials used, process parameters etc for various RP processes.
- The concepts in design and process optimization should help the student use CAD models for slicing and creating CAD models from real objects for research. Product design and analysis etc.
- The concepts in reverse engineering should help the student gain knowledge in creating CAD models from real objects for research. Product design and analysis etc

MODULE 1

(12 hours)

INTRODUCTION: Need for the compression in product development. Role of RP in CIM. Role of 3D solid modelling software in RP. Survey of applications. Classification of RP systems

STEREO LITHOGRAPHY SYSTEMS: Principle, Process parameter. Process details. Data preparation. Data files and ,machine details. Application.

SELECTIVE LASER SINTERING: Type of machine. Principle of operation. Process parameters. Data preparation for SLS, Applications.

MODULE 2 (12 hours)

FUSION DEPOSITION MODELLING: Principle, Process parameter, Path generation. Applications.

SOLID GROUND CURING: Principle of operation, Machine details, Applications.

LAMINATED OBJECT MANUFACTURING: Principle of operation, LOM materials. Process details, application.

MODULE 3 (12 hours)

CONCEPTS MODELERS: Principle, Thermal jet printer, Sander's model maker, JP systems5, Object Quadra systems.

RAPID TOOLING: Silicone rubber tooling, Aluminium filled epoxy tooling, 3D Keltool process, Direct AIM, Copper polyamide, DTM rapid tool process.

RAPID MANUFACTURING PROCESS OPTIMIZATION: Factors influencing accuracy, Data preparation errors, Part building errors, Error in finishing, Influence of build orientation.

MODULE 4 (11 hours)

DESIGN MODELLING FOR RP: The STL File. The SLC Format, Model Slicing, Choosing a System

SOFTWARE FOR RP: Overview of Solid view, magics, imics, magic communicator, etc. Internet based software, Collaboration tools.

REVERSE ENGINEERING: 3D scanning, 3D digitizing and Data fitting, Surface generation from point cloud, Surface modification-data transfer to solid models, Overview of digitizing software's, Case studies.

Text Books

1. Stereo Lithography and other RP & M Technologies, Paul F. Jacobs: SME, NY 1996.
2. Rapid Manufacturing, Flham D.T & Dinjoy S. S, Springer- Verlog London 2001.
3. Computer Aided Manufacturing, Tien Chien Chang, Richard A. Wysk, Hsu Pin Wang, Pearson Education 2011

References Books

1. Rapid Prototyping, Terry Wohler's Report 2000" Wohlers Association 2000.
2. Rapid Prototyping Materials, Gurumurthi, Hsc Banglore
3. Rapid Automated, Lament wood. Indus press New York.

ME 7.5.4 DESIGN OF THERMAL SYSTEMS

L T P

Lecture per week: 3+1+2
Max. marks for theory paper: 100
Max. marks for sessiona1s: 25
Max. marks for orals: 25
Total no. of questions from each module 2
Total no. of questions to be answered: 5 (At 1least one question from each module.)
Course Objectives:
Use the information described in the course description to properly model and design energy systems.

Instructional Objectives:
The primary objective of this course is to provide design experience in problems involving thermal systems. In this course students, working in groups, apply the principals developed in thermodynamics. Fluid mechanics, and heat transfer to the solution of open-ended.client-based design problems.

MODULE I (12+3)

Introduction to Thermal Systems Design:

Principals of heat transfer, Types of heat exchangers, Standerd representation. Parts description, TEMA Classifications, Applications.

Review of Fluid Properties and Basic Equations of Fluid Mechanics

Piping systems, Head losses, Design of piping systems – series and parallel Design of Piping networks.

MODULE II (12+4)

Design of Heat Exchangers

Heat Exchangers-Classification and Selection, LMTD. E-NTU methods, Founding.

Thermal-Hydraulic Fundamentals

Shell and tube heat exchanger- Tinkers, Kern's and Bell Delaware's method, design methodology, Methodology for thermal design of heat exchanges; rating and sizing problems, Pressure drop calculations.

MODULE III (12+4)

Design of Condenser

Estimation of heat transfer coefficient, Fouling factor, Friction factor, Design procedures, Wilson plots, Designing, different types of condensers BIS standers, Optimisation studies.

Design of Evaporator

Different types of evaporators, Design procedure, Selection procedure, Thermal stress calculations, matching of components, Design of evaporative condensers.

MODULE IV (12+4)

Design of Cooling Tower

Types of cooling towers, Analytical and graphical design procedures, Tower characteristics, Parametric analysis, Packaging, Water treatment, Selection of pumps and fans, Energy conservation.

Waste heat recovery systems, applications & techno economics

Recuperators – Regenerators – economizers – Plate Heat Exchangers – Waste Heat Boilers – classification, Location, Service conditions, Design Considerations, Unfired combined cycle – supplementary fired combined cycle – fired combined cycle applications in Industries – fluidized bed heat exchangers – heat pipe exchangers – heat pumps – thermic fluid heaters selection of waste heat recovery technologies – financial considerations – operations and investment costs of waste heat recovery.

Text Books

1. A. P. Frass and M. N. Ozisik, "Heat Exchanger Design", McGraw Hill, 1984.
2. D.C.Kern, "Process Heat Transfer", McGraw Hill 1950
3. Ozisik M.N., Heat transfer, McGraw-Hill,1988

References Books

1. Ozisik, M.N. Design of Heat exchangers, condensers and evap[orators, John Wiley, New York, 1985
2. Institute of Fuel, London, Waste Heat Recovery, Chapman & Hall Publishers, London, 1963.
3. Sengupta subrata, Lee SS EDs, Easte Heat Utilization and Management, Hemisphere, Washington, 1983.

M.E. 7.5.6 APPLIED OPERATIONS RESEARCH

	L T P
Lectures per week	: (3 1 2)
Max. marks for theory paper	: 100
Max. marks for session	: 25
Max. marks for oral	: 25
Duration of paper	: 3 hours
Total no. of modules	:4
Total no. Of question from each module	:2
Total no. Of questions to be answered	:5(At least on question from each module with two compulsory question from any one module)

COURSE OVERVIEW: - This course provides a comprehensive insight into various quantitative models available in Operations Research.The focus of the course in on LP models ,Transportation Model, Assignment model and IP model. In addition ,the course also discusses Decision Theory,Game Theory, DP models,Network Model and Queuing Theory.Simulation is also discussed with in troduction to GPSS.

INSTRUCTIONAL OBJECTIVES: - This course will enable the students to understand the difference between various prescriptive as well as descriptive models, their limitations. The students would learn the solution methodology of each model. The course would introduce GPSS to model simple real life situations with queuing background.

MODULE I

Operations Research:Origin and development,Feature or OR, Methodology of OR,

Linear Programming Model:Formulation of real life situations, Solutions methodology:

Graphical method,simplex method.Special cases:- Unbounded, In-feasible, Alternate and Degenerate solution

Two phase method,Duality Theory,Dual simplex method,Post Optimal Analysis

MODULE II

Transportation Model:Formulation, Transportation algorithm Developing initial BFS using North West corner Rule,Leat cost cell method,VAM,.Testing the solution and improving using stepping Stone method and MODI method.Resolving unbalance, degeneracy,Transshipment **Model**

Assignment Model: Formulation,Hungarian Algorithm,Tackling Unbalance

Integer Programming: Classification,Introduction to Branch and Bound method, Gomory's Cutting Plane Algorithm for pur and mixed IP.

MODULE III

Decision Theory,Pay off table,Regret Table,Various Decision Rules; Decision Trees.

Game Theory Two person Zero Sum game, Formulation, pure strategy and Mixed strategy, Solution Methodology: Graphical method and LP method

Dynamic Programming: Decomposition stages,Recursive equations,Capital Allocation Model,Knap-Sack model,Stage coach model and their variants.

Network Models: Shortest path problem,Minimum Spanning tree problem,Maximum flow problem

MODULE IV

Queuing theory,General structure of system,General expression for system with Poisson arrival and Exponential service,Analysis of M/M/1 with infinite population and Self service system.

Simulation: Advantages and Limitations,Discrete simulation, importance of Pseudo-random Numbers.

Introduction to GPSS: syntax and working of ststements TERMINATE,START, GENERATE, ADVANCE,QUEUE-DEPART,ENTER-LEAVE,SEIZE-RELEASE,TRANSPER,GATE,TEST, LOGIC,modelling of simple systems using these blocks

TEXT BOOKS AND REFERENCES

Vohra N D:Quantitative techniques in Management,2nd ed. Tata McGraw Hill Publishing Co.Ltd. New Delhi.

Hamdy Taha:Operation research,an Introduction,Mac Millan Publishing Co.

Hiller,Liberman:Introduction to Operations Research,McGraw Hill International

Gupta,Hira:Operations Research S. Chand and Co.

Sharnma S D:Operations Research Kedarnath & Ramnath Publications.

ME 7.5.7 AUTOMOBILE ENGINEERING

Lecture per week: 3+1+2
Max. marks for theory paper: 100
Max. marks for sessiona1s: 25
Max. marks for orals: 25
Total no. of questions from each module 2
Total no. of questions to be answered: 5 (At 1east one question from each module.)

Course Objectives: This is a course with knowledge to be gained from study of various automobile systems. The knowledge can be used in the design and service sectors of Automobiles.

Instructional Objectives: The functions, requirements and operational aspects of the various systems are dealt at length enabling students to understand the automobile. Performance of automobiles is also evaluated along with exposure to rece

MODULE I

Frames: Construction, function, loading, location of engine and drive, front wheel drive, four wheel drive and rear engine construction. **(2+0)**

Power Plant : Principles of Engine operation, Engine parts and their functions, multiple Cylinder engines, engine troubles and repairs, cooling systems, Lubrication systems, Fuel systems. **(4+0)**

Petrol and Diesel Fuel systems, Common Rail system, Inline Pump System, engine troubles & repairs **(2+0)**

Clutches: Dry friction clutches, electromagnetic clutch, clutch material, clutch trouble shooting **(3+2)**

MODULE II

Wheel Gear Boxes: Necessity of gear box, sliding mesh, constant mesh, synchromesh and epicyclic, overdrives, and torque converter. **(4+2)**

Wheels and Tyres: of wheels tyre constructional features and characteristics. **(2+0)**

Front axles and steering : Typ Front axles and steering: Types of front axles and their construction, front wheel drive, wheel aligment, steering geometry, steering gear requirement, wheel balance, steering mechanisms, and characteristics, Types of steering gears, power starring, steering trouble shooting. **(4+1)**

Brakes: Theory of shoe brakes, shoe factors, weight transfer, brake power ratio, hydraulic, power air and vacuum brakes. **(3+1)**

MODULE –III

Final Drive: Differentials, rear axles, propeller shafts, couplings. **(2+1)**

Suspension: Various suspension systems, Independent front and rear suspension, shock absorbers, pitching, bouncing and rolling. **(2+1)**

Vehicle performance: Resistance to the motion og vehicles-air rolling, gradient resistances power requirement for acceleration and grade ability, selection of suitable rear axle & gear ratio. **(6+2)**

Electrical system: Lead Acid Battery, Types of ignition system, Engine starting system, Automobile Air conditioning. **(2+1)**

MODULE –IV

Automobile safety: Preventive safety design and design consideration of an automobile to minimize injury in case of accidents. **(2+1)**

Automobile Pollution control: Emission standards, Pollutants emitted by automobile and methods to control pollution. **(2+1)**

Recent advances in automobiles: Variable valve timing, Electronic fuel injection, Adaptive suspension system, Active roll control system, hybrid vehicles, Fuel cells, heavy haulage vehicles. **(3+1)**

Basic features two wheelers and three wheelers

Transmission system, Suspension system, Brake system. **(2+1)**

TEXT BOOKS

1. Heitner, Automotive Mechanics
2. Kirpal singh,Vol I&II ,Automobile Engineering.

REFERENCE BOOKS

1. Newton Steads, Motor Vehicle.
2. Crouse, Automotive Mechanics.
3. Automotive Mechanics ED May Vol II

ME 7.5.8: MICROELECTROMECHANICAL SYSTEMS (MEMS)

	LTP
Lecturers/tutorial/Practical per week	3+1+2
Max. marks for theory paper:	100
Max. marks for sessionals	25
Max. marks for orals	25
Total No. of questions from each module	2
Total No. of questions to be answered	5(At least one question from each module)

COURSE OBJECTIVES

- To provide an overview of Microsystems and their application in various branches of Engineering medical science and basic sciences.
- To throw light upon the actuation methods, design, packaging and modeling of MEMS devices.
- To provide an insight into various microfabrication technologies.

INSTRUCTIONAL OBJECTIVES

- The students should be able to apply the concepts learnt in designing and fabricating MEMS devices

- The students should be able to use the knowledge for pursuing research in the area of MEMS

MODULE -1

Introduction to Micro and Smart Systems: Smart materials, Structures and systems, Components of a smart system, Microsystems, Feynman's vision, Micromachined transducers, Multi-disciplinary aspects, Applications areas, Commercial products.

Micro manufacturing And Material Processing: Silicon wafer processing, Lithography, Thin-film deposition, Etching (wet and dry), Wafer-bonding and Metallization, Silicon micromaching: Surface, bulk moulding, Thick-film processing, Smart material processing, Processing of other materials: ceramics, polymers and metals

(12 Hours)

MODULE -2

Micro & smart Devices & Systems: Definitions and salient features of sensors, actuators, and systems, *Sensors*: Silicon capacitive accelerometer, Piezo-resistive pressure sensor, Blood analyzer, Conductometric gas sensor, Fiber-optic gyroscope and surface-acoustic-wave based wireless strain sensor, *Actuator*: Silicon micro-mirror arrays, Piezo-electric based inkjet print-head, Electrostatic comb-drive and micromotor, Magnetic micro relay, Shap-memory-alloy based actuator, *Electro-thermal actuator System:* Micro gas turbine, Portable clinical analyzer, Active noise control in a helicopter cabin Introduction to RF-MEMS, BIO-MEMS, high temperature MEMS and optical MEMS (Basic concept only) **(11 hours)**

Surface-acoustic-wave based wireless strain sensor, actuators: silicon micro mirror arrays, Piezo-electric based inkjet print-head, Electrostatic comb-drive and micromotor, Magnetic micro relay, shape-memory-alloy based actuator, Electro-thermal actuator Systems: Micro gas turbine, Portable clinical analyzer, Active noise control in a helicopter cabin

Introduction to RF-MEMS, BIO-MEMS, high temperature MEMS and optical MEMS (Basic concepts only) (11 hours)

MODULE-3

Modeling: Scaling issues, Elastic deformation and stress analysis of beams and plates, Residential stresses and stress gradients, Thermal loading, Heat transfer issues, Basic fluid issues Electrostatics. Coupled electromechanics. Electromagnatic actuation. Capillary electro-phoresis. Pieszoresistive modeling. Piezoelectric modeling. Megntostrictive actuators.

Microsystem Design:Thermomechnical stress analysis, Dynamic analysis, Design of a Silicon die for micropressure sensor, design of microfluidic network system: Fluid resistance in microchannels **(12 Hours)**

MODULE-4

Integration and Packaging of Micro electro Mechanical Systems: Integration of microelectronics and micro devices at wafer and chip levels. Microelectronic packaging: wire and ball bounding, flip-chip, Low-temperature-cofired-ceramic(LTCC) multi-chip-module technology,Microsystem packaging examples.

Case Studies: BEL pressure sensor, thermal cycler for DNA amplification, and active vibration control of a beam. **(10 Hours)**

TEXT BOOKs:

1. MEMS & Microsystems: Design and Manufacture, Tai-Ran Tsu, Tata Mc- Graw-Hill
2. MEMS- Nitaigour Premchand Mahalik, TMH 2007
3. MEMS and MOEMS Technology & Applications, P. Rai Choudary, PHI learning Pvt Ltd, New Delhi, 2009.

REFERENCE BOOKS

1. Microsystem Design, S.D. Senturia, 2001, Kluwer Academic Publishers, Boston. USA.ISBN 0-7923-7246-8.

2. Analysis and Design Principles of MEMS Devices, Minhang Bao, Elsevier, Amsterdam, the Netherlands, ISBN 0-444-51616-6.

3. Design and Development Methodologies, Smart Material System and MEMS: V Varadan, K.J. Vinoy, S. Gopalkrishnan, Wiley.

4. Fundamentals of mocro fabrication, the science of miniaturization – Max J. Madou, Nanogen corporation, USA, CRC press, March 2002.

ME 8.1: RELIABILITY BASED DESIGN

	L +T+P
Lectures/Tutorials/Practical's per week	**: 3+1+0**
Question Paper Duration	**: 3 Hrs**
Max marks for theory paper	**: 100**
Max. marks for sessionals	**: 25**
Max. marks for orals	**: 50**
Total no. of questions from each module	**: 2**
Total no of questions to be answered	**: 5 (At 1east one question from each module.)**

Course Objectives:

Students will be able to understand the importance of reliability and quality in the design and manufacture of engineering products, components and systems. Probabilistic design methodology which deals with real-life cases is also dealt in this course. Optimization and its application to reliability in design, is explained with different types of methods of optimization.

Instructional Objectives:

The course begins with introduction to reliability and various failures density functions. Different optimization methods are covered with emphasis on solving numericals and understanding concepts behind each method. The course concludes with probabilistic design methodology.

MODULE 1 (12+4)

Need for Reliability based design, definition of reliability and its various measure, analysis of standard failure density function like Exponential Normal. Log Normal Gamma and Weibull distribution. Various methods to improve reliability, Redundancy, calculation of system reliability for series, parallel and Complex s Allocation and Optimization of system reliability., Formulation of reliability Optimization problem as NLP

MODULE 2 (12+4)

NON LINEAR OPTIMIZATION: Optimization in design, need. Concept of adequate. Optimum and Robust design. Formulation of design problem. Classification of design problems, Classification of Optimization in methods, Condition of optimality, Classical techniques, Single variable optimization techniques. Unrestricted search, Dichotomous search, Interval halving method, Golden Section method. Fibonacci search method, Bisection method, Secant method, Newton Ralph a method.

MODULE 3

(12+4)

Multi-variables optimization techniques without constraints: Random search method, Univariate method, Patten search method, Powell's Conjugate Gradient method. Simplex method for NLP.

Multi-variables optimization techniques with constraints; KTC conditions,

Variable elimination method, Lagrange's method, Cutting Plane method.

Introduction to Unconventional optimization techniques like Genetic Algorithm, Simulated Annealing, Tabu Search.

MODULE 4

(12+4)

Probabilistic design methodology: Interference theory, calculation of reliability of with stress and strength having exponential, normal, lognormal, gamma and weibull distribution.

Design of mechanical components.

Concepts of maintainability, Availibility, serviceability.

TEXT BOOKS

1. Kalyanmoi Deb: Optimisation for engineering Design Prentice Hall India.

2. Ashok Belegundi, T Chandrauptala: Optimisation concepts and applications in engineering, Pearson Education.

3. Rao S. S., Reliability Based Design, McGraw Hill

REFERENCES:

1. Rao S.S.: Optimisation theory and applications. Wiley Eastern Ltd.

2. Kapur K.C: Reliability in Engineering design.

3. Arora J. S. Introduction to optimum Design, Elsevier academic Press

ME 8.2: POWER PLANT ENGINEERING

	L +T+P
Lectures/Tutorials/Practical's per week	**: 3+1+0**
Question Paper Duration	**: 3 Hrs**
Max marks for theory paper	**: 100**
Max. marks for sessionals	**: 25**
Max. marks for orals	**: 50**
Total no. of questions from each module	**: 2**
Total no of questions to be answered	**: 5 (At 1east one question from each module.)**

Couse Objectives

To provide and deliver the highest quality course in Power Plant Engineering with the highest standards and continuously encouraging and inspiring students to strive for excellence and perfection in all their endeavors.

Instructional Objectives

1. **To understand the Principles of Operations and Applications of Thermal Power Plants. (Steam Turbines, Gas Turbines and Combined Cycle Plants).**
2. **To understand the factors which affect the performance characteristics of Thermal Power Plants and their components.**
3. **To understand working principle and technologies used in Non-conventional Power generation and Direct Energy Conversion.**
4. **To understand economics of power generation.**

MODULE I

1.1 Introduction (12+4)

Power Plants: Factors affecting Selection of site, Principal types of the power plants and combustion of fuel, Schematic Diagrams and relative merits of Steam ,Gas Diesel ,Hydro Power Plants, Present status of Power generation in India.

1.2 Economics Power Generation

Load curves, load duration curves, Connected load , maximum load , peak load, base load, and peak load power plants. load factor, plant capacity factor, plant use factor, demand factor, diversity factor. Performance at variable load of power plants, heat rate and incremental heat rate curves, load sharing among generators and prime movers, load shading between power stations, cost analysis, unit energy cost. Cost analysis, selection of type of generation, economics in plant selection and Economic load shearing.

MODULE II

(12+4)

Improved Rankine Cycles

Rankine cycle, Rankine Cycle with Reheating and Regeneration. Binary Vapour Cycle, Steam Power Plants with Process Heating, cogeneration, Numerical.

Thermal Power Plants

Introduction to thermal power plants, detailed layout, Fuel for thermal power plants, selection of thermal power plants, Handling , storage preparation & feeding, burning of fuels, Ash handling & dust collection, Draught system, Principle of Fluidized bed combustion.

MODULE III

(12+4)

Nuclear Power Plants.

Classification, Site Selection, Types of Various Reactors with working of various Components. Nuclear Power plants In India. Pressurized water reactor, Boiling water reactor, Gas cooled reactor, Heavy water reactor, Nuclear Waste Disposal.

Gas Turbine Power Plants

General Aspects, Gas turbine fuels, Modified gas turbine cycles for power generation, Effect of operating variables on Thermal Efficiency, Combined cycle power plant: Gas turbine and steam and Gas turbine diesel power plant, various arrangements of Gas turbine power plants, Numericals.

MODULE IV

(12+4)

Non-conventional Power generation and Direct Energy Conversion

Introduction, Wind power plants, wind electricity economics, Tidal power plants, Solar Power plants, Geothermal power plants, Biogas plants, Thermoelectric conversion systems, Thermionic conversion system, Photovoltaic power system, Magneto hydrodynamics (MHD), Fuel cells, Nuclear batteries.

Pollution and Its control

Introduction, Pollution from Thermal Power Plant, Gaseous emission and its control, particulate emission and its control, solid waste disposal, thermal pollution, pollution from nuclear power plants, pollution from hydro-electric power plants and solar power generating stations.

Text Books

1. Nag P.K.: Power Plant Engineering, TMH
2. Domkiundwar V.S.: Power Plant Engineering. Dhanpat Rai & Sons
3. Rao G.D.: Non Conventional Energy Sources. Dhanpat Rai & Sons.

Reference Books

1. Sukhatme S.P. Solar Energy, TMH
2. Leon Freris, David Infield, Renewable Energy in Power Systems. John Wiley
3. Power station Engineering and Economy by Bernhardt G.A. skrotzki and William A. Vopat – Tata Mc Graw Hill Publishing Campany Ltd., New Delhi
4. Power Plant Engg. : M.M. El-Wakil McGraw Hill 1985.

ME 8. 3.1: FINITE ELEMENT METHODS

	L +T+P
Lectures/Tutorials/Practical's per week	**: 3+1+0**
Question Paper Duration	**: 3 Hrs**
Max marks for theory paper	**: 100**
Max. marks for sessionals	**: 25**
Max. marks for orals	**: 50**
Total no. of questions from each module	**: 2**
Total no of questions to be answered	**: 5 (At 1east one question from each module.)**

Module I (12+4)

Introduction: Brief history of the development of the subject of FEM. Overview of the method, range of applications.

Basic Equations from linear theory of elasticity: Stress and strain tensors and their properties, Generalised Hooke"s law, Elastic constants for isotropic materials, Equilibrium equations, Compatibility equations, Caushy's equations, Plane stress and plane strain problems, A problem of theory of elasticity, Bi-harmonic equation. Airy's stress function.

Energy Method to solve problems in Mechanics of solids: Strain Energy at a point under the given state of stress, Maxwell-Betti's reciprocal theorem Castigliano's theorems. Virtual work principle, Rayleigh-Ritz method. Applications

Module II (12+4)

Basic Equations from Fluid Mechanics

Basic Equations from Heat Transfer

Variational Calculus: Introduction, Functional and it's minima

Analysis of Truss by matrix methods,

Module III (12+4)

Mathematical Approach: Variational approach, FEM and Ritz method element equations from Variational Principle, Finding variational principles for the problem, Methods of Weighted resaidue, Gelarkin, Collocation techniques, least square methods to solve the differential equations.

Elements and interpolation functions stiffness matrix and the equilibrium equations: Formulation based on generalized co-ordinates. Convergence requirements. Natural Co-ordinates, Numerical integration. Newton-Cotes and Gauss Legendre quadrature.

Assembly of global stiffness matrix and inserting boundry conditions and solution of linear system of equation: Gauss elimination. Gauss-Siedel. Cholesky's decomposition. Crout's factorization to solve the liner system of equation, Nature of the stiffness matrix

Module IV **(12+4)**

Application of FEM to Problems: Structural dynamics. General field problems such as torsioa, heat condition. Irritation, irrotational flow.

Subject project(To be presented at the time of oral exam): Formulation and development of FEM code to solve problem from the topics such as stress analysis Dynamics, Heat transfer etc.. Exposure to FEM software such as ANSYS.

Text Books:

1) Reddy J.N. an Introduction to the Finite Element Method MeGraw-Hill Book Company.
2) Belegundu and Chandraupatla, Introduction to Finite Elements in Engineering. Second Edition. Prentice hall of India Pvt. Ltd. New-Delhi
3) Desai and Abel FEM

References:

1) Batha K. J. Finite Element Procedures. Prntice-Hall of India, Pvt Ltd, New Delhi
2) Finite element analysis, Krishnamoorthy

ME 8.3.2: INDUSTRIAL ROBOTICS

	L +T+P
Lectures/Tutorials/Practical's per week	**: 3+1+2**
Question Paper Duration	**: 3 Hrs**
Max marks for theory paper	**: 100**
Max. marks for sessionals	**: 25**
Max. marks for orals	**: 50**
Total no. of questions from each module	**: 2**
Total no of questions to be answered	**: 5 (At 1east one question from each module.)**

Course Objectives

- **To understand the structure ,classification & performance characteristics of a robot**
- **To study control systems and sensors used in robotics**
- **To introduce students to the forward & inverse kinematics of robots**
- **To provide a glimpse of robot dynamics**
- **To throw light on programming in robotics**
- **To learn the concepts in mobile robots & machine vision**

Instructional Objectives

- **The student should be able to apply the concepts learnt in design of robots.**
- **The study of programming languages should help the student to program robots for specific tasks and path.**
- **The concepts learnt should help the student to develop algorithms for robot motion and for frame transformations**

MODULE I

Basic Concepts in (Fundamentals of) robotics: Automation and robotics, robot anatomy, Basic structure of robots, D O F. & degree of motion, joints & symbols, Work volume & envelope, Robot motions, resolution, accuracy and repeatability.

Classification and structure of robotic systems: Point to point and continuous path systems, Grippers, Design of grippers.

Drives and Control systems: Hydraulic and pneumatic systems, Control loop of robotic systems, Control approaches utilizing current and voltage amplifiers, Robot joint control design

MODULE II

Robot arm kinematics: The direct kinematics problem, Denavit Hartenberg convention and its applications, Generation of motion commands, Trajectory planning, the inverse kinematics solution for 2 axis planar mechanisms, 3 axis spherical, and 6 axis manipulators.

Introduction to robot dynamics: Stiffness control of robot end effector, Dynamic equations for robots.

MODULE III

Sensors in Robotics: Touch sensors, Force and torque sensors, Acoustic sensors, Slip sensors, Proximity & Range sensors

Robot Programming: Lead through programming methods, Robot program as a path in space, Motion interpolation, WAIT, SIGNAL and DELAY commands., Branching, Programming the maker robot- The teach pendant, Moving the robot, Teaching Points, Teaching programs.

Robot Language : Robot language structure, constants, variables & other data objects, Motion commands, End effectors and sensor commands, Computations & operations, Program control and subroutines, Communications & data processing, Monitor mode commands, VAL II.

MODULE IV

Machine Vision: Introduction, Sensing & digitizing function, Imaging devices, Lighting techniques, Image storage, Image processing and analysis , Image data reduction, segmentation, Feature extraction, Object recognition, Training the vision system , Robotic applications

Mobile robots: Introduction, Key issues for locomotion, Legged mobile robots, Leg configuration and stability, Types, Wheeled mobile robots, Wheel design, , Path planning – configuration space, Road map path planning, Cell decomposition path planning, Obstacle avoidance- bug algorithm, Vector field histogram

Text Books

1. Yoram Korean: Robotics for engineers, McGrew Hill Co.
2. M.P.Groover, M.Weiss, R.N.Nagel, N.G.Odrey Industrial Robotics Technology, programming and Applications.
3. K.S.Fu, R.C.Gonzalex, C.S.G.Lee: Robotics Control Sensing, Vision and Intelligence, McGraw Hill Book co.

References

1. Hartenberg and Denavit: Kinematics and Synthesis of linkages, McGraw Hill Book Co.
2. Roland Siegwart & Illah R. Nourbakhsh: Introduction to Autonomous Mobile Robots, Prentice hall of India.
3. Sabrie Solomon: Sensors & control systems in manufacturing, McGraw Hill Professional Publishing.
4. John J. Craig: Introduction to Robotics, Mechanics & Control, Pearson Education Inc.
5. Mittal: Robotics, John Wiley

ME 8.3.3: COMPUTATIONAL FLUID MECHANICS

	L +T+P
Lectures/Tutorials/Practical's per week	**: 3+1+2**
Question Paper Duration	**: 3 Hrs**
Max marks for theory paper	**: 100**
Max. marks for sessionals	**: 25**
Max. marks for orals	**: 50**
Total no. of questions from each module	**: 2**
Total no of questions to be answered	**: 5 (At 1east one question from each module.)**

MODULE I **(12+4)**

Introduction: Philosophy of CFD, CFD as research tool. CFD as a design tool, Impact of CFD

The Governing Equations of Fluid Dynamics: Models of flow, Substantial Derivative. Divergence of the velocity, Continuity equation, Momentum equation, Energy equation, Physical boundary conditions.

MODULE II **(12+4)**

Mathematical behavior of partially differential equations: Quasi liner differential equations, Eigen Value Method, General behavior of different classes of partial differential equations.

Basic Aspects of Discretization: Introduction to finite differences. Explicit and Implicit approaches, Errors and analysis of stability.

MODULE III **(12+4)**

Grids with appropriate transformation: General transformation of equations, Matrices and Jacobians, From of governing equations, Compressed grids, Boundry fitted co-ordinate systems, adaptive grids, modern developments in grid generation and In finite volume mesh.

MODULE IV **(12+4)**

Computational Fluid Dynamic techniques: Comments on Viseous flows. Conservation from and space marching. Relaxation techniques and its use with low speed inviseid flow, Aspects of numerical dissipation and dispersion. Alternating direction Implicit Pressure correction technique. Computer graphic techniques used in CFD.

TEXT BOOK

1. **JOHN D. ANDERSON: Computational fluid dynamics, McGraw Hill International Edition.**

ME8.3.4: MAINTENANCE ENGINEERING & MANAGEMENT

	L +T+P
Lectures/Tutorials/Practical's per week	**: 3+1+2**
Question Paper Duration	**: 3 Hrs**
Max marks for theory paper	**: 100**
Max. marks for sessionals	**: 25**
Max. marks for orals	**: 50**
Total no. of questions from each module	**: 2**
Total no of questions to be answered	**: 5 (At 1east one question from each module.)**

MODULE I

(12+4)

Necessity of Maintenance Management, Objectives, Importance & Functions of Maintenance, Types of Maintenance, Condition Based Maintenance. Economic Aspects of in Maintenance, Organization of Maintenance Department, Categories of Maintenance Selective control, Evaluation of Maintenance Performance, TPM, Management Techniques used in Plant Maintenance, Inspection & Lubrication, Computers in Maintenance, Maintenance budget. New trends in Maintenance.

MODULE II

(12+4)

Fundamentals of Reliability, Failure Distribution, Reliability Measures. Constant Failure Rate Model (Exponential), Time Dependent Failure Models (Normal, Lognormal, Weibull), Reliability of Systems (Series, Parallel, Complex), Stand-by Systems.

MODULE III

(12+4)

State dependent systems, Reliability allocation, Fault tree analysis in Maintainability, Analysis of Downtime, Repair Time Distribution, Reliability under Preventive Maintenance, State Dependent system with Repair, Standby system with Repair.

MODULE IV

(12+4)

Replacement Policies, Maintenance Requirements, Maintainability Design Methods, Maintainability Prediction & Demonstration, Maintainability Allocation.

Availability, it's Concepts & Definitions, Availability in odds, System Availability, Standby System Availability, Steady State Availability.

TEXT BOOK:

1. Charles E. Ebeling: "An Introduction to Reliability and Maintainability Engineering" Tata Mc Graw Hill Publication.
2. Anthony Kelly: "Maintenance Planning and Control" East West Press.

REFERENCE:

1. Srinath L.S. "Reliability Engineering" East West Press.

E 8. 3. 5: SYSTEM SIMULATION

	L +T+P
Lectures/Tutorials/Practical's per week	**: 3+1+2**
Question Paper Duration	**: 3 Hrs**
Max marks for theory paper	**: 100**
Max. marks for sessionals	**: 25**
Max. marks for orals	**: 50**
Total no. of questions from each module	**: 2**
Total no of questions to be answered	**: 5 (At 1east one question from each module.)**

MODULE I **(12+4)**

Defination, need modeling concepts. Types of system studies.
Random numbers:Need, Importance and desirable properties
Generation of random numbers with Bernoullis Trial, Binomial, Geometric, Pascal Exponential, Uniform, Normal, Erlang distribution.
Next event approach, Fixed time increment approach and process oriented approach for system simulation.

MODULE II **(12+4)**

Simulation of inventory system, queuing system, project network
Application of simulation for solving deterministic model like evaluation of definite integral, finding value of rot, area of circle.
Application of simulation in simple simulation of simple games.

MODULE III **(12+4)**

GPSS: Introduction to various block statements and control statements. GENERATE, ADVANCE, SEIZE, RELEASE, QUEUE,DEPART, ENTER, DEPART, TRANSFER, MARK, TABULATE, TERMINATE, SAVEVALUE, PRIORITY, ASSIGN, GATE, LOGIC, FUNCTION, START, RESET, JOB, SIMULATE
Various Standard Numeric attributes
Modeling of various systems using GPSS

MODULE IV **(12+4)**

Testing the random numbers for the various distributions.
Estimation of parameters
Analysis of simulation output determining the length of simulation, effect of initial bias, effect of auto-correlation, Variance Reduction techniques. Introduction to continuous simulation and CSMF

TEXT BOOKS

1. System Simulation, Geoffrey Gorden, Prentice Hall of India, New Delhi
2. Digital Computer Simulation, Fred J Maryanski, CBS Publishers & Distributors
3. Digital simulation by Narsingh Deo, PHI

ME 8. 3. 6: CONTROL SYSTEM ENGINEERING

	L +T+P
Lectures/Tutorials/Practical's per week	**: 3+1+2**
Question Paper Duration	**: 3 Hrs**
Max marks for theory paper	**: 100**
Max. marks for sessionals	**: 25**
Max. marks for orals	**: 50**
Total no. of questions from each module	**: 2**
Total no of questions to be answered	**: 5 (At 1east one question from each module.)**

MODULE I (12+4)

Feed back control systems. Historical development, System representation, modern control systems.

Representation of control components: Operational notations. Mechanical components, electrical components, series & Parallel law analogies, scale factors.

Thermal systems, fluid systems.

Representation of control systems: Linearisation of non liner functions, Linearisation of operating curves, hydraulic systems, pneumatic systems, DC motors, AC motors, Block-diagram algebra, speed control systems.

MODULE II (12+4)

Steady state operations: Steady state analysis, equilibrium, proportional control systems, integral control systems & their combination.

Laplace transforms: Classical methods, Laplace transform method, transforms properties, initial conditions, general procedures, convolution integral, error coefficients.

MODULE III (12+4)

Transient response: transformations. Complex conjugate zeros damping ratio & natural frequency. Computer solution transient response specification, general form of transient response to an external disturbance. Rouths stability criterion.

The Root – Locus Method: Significance of root loci. Construction of loci general procedure. Loci equations of parameters.

MODULE-IV (12+4)

System representation, signal flow graph. Solution of state spare equations transfer functions, multi variable system

Frequency response method: Logarithmic representation. Evaluation of gain. Polar plots. Correction between transient & frequency response.

Text Books :

1. Benjamic C Kuoi- Automatic Control Systems. PHI
2. Ogata Modern control Engineering PHI

Reference:

1. Raven F. H.- Automatic Control Systems. Engineering MGH

ME 8.3.7: ENERGY MANAGEMENT

L

L+T+P

Lectures/Tutorials/Practical's per week : 3+1+2
Question Paper Duration : 3 Hrs
Max marks for theory paper : 100
Max. marks for sessionals : 25
Max. marks for orals : 50
Total no. of questions from each module : 2
Total no of questions to be answered : 5 (At 1east one question from each module.)

Course Objectives:
This course will help students acquire the basic knowledge required to implement energy management. The course also includes tutorials to help students understand the concepts involved.

Instructional Objective:

1. **To build a solid foundation in the fundamentals of Energy Management**
2. **To encourage a "hands-on" approach to solving Energy saving and efficiency problems**
3. **To provide up-to-date energy efficiency solutions to thermal and electrical utilities.**

MODULE I

(12+4)

Introduction : energy and environment, need for renewable and energy efficiency, need and importance of energy conservation and management.
Energy consumption patterns and energy conservation opportunities in Indian industry, agriculture, commercial and residential sectors.
Energy Auditing - methodology, analysis and reporting. Portable and on-line instruments used for energy auditing.

MODULE II

(12+4)

Costing of utilities : Determination of cost of steam, compress air and electricity. Methods of financial analysis :

1) **Simple payback period**
2) **Time value of money (future value, net present value)**
3) **Return on investment (ROI)**
4) **Internal rate of return (IRR)**

Cogeneration: Definition, Need, Application, Advantages, Classification, Saving potentials

MODULE III

(12+4)

Energy conservation in refrigeration and air conditioning system, compressed air system. Energy conservation in steam generation and supply system. Boiler performance, Boiler efficiency

Waste Heat Recovery: Classification, Advantages and applications, Commercially viable waste heat recovery devices, Saving potential

MODULE IV

(12+4)

Insulation : Materials of insulations, form of insulations, desirable properties of insulations, economic thickness of insulation. Refractories.

Electrical systems : energy conservation in motors, energy efficient motors, power factor improvement, , variable speed drive.

Lighting : Illumination levels, fixtures, timers, energy-efficient illumination.

Text Books:

1) Energy Conservation - related booklets published by National Productivity Council (NPC), New Delhi
2) Petroleum Conservation Research Association (PCRA), New Delhi..

References:

1) IGC Dryden, editor : The Efficient use of Energy (Butterworths).
2) W.S. Turner, Editor : 2) Energy Management Handbook (Wiley).
3) Patrick Steven R., Patric Dale R., Fordo Stephen : Energy Conservation Guide Book, The Fairmont Press Inc.

ME 8.4.1: PRECISION ENGINEERING

	L +T+P
Lectures/Tutorials/Practical's per week	**: 3+1+2**
Question Paper Duration	**: 3 Hrs**
Max marks for theory paper	**: 100**
Max. marks for sessionals	**: 25**
Max. marks for orals	**: 50**
Total no. of questions from each module	**: 2**
Total no of questions to be answered	**: 5 (At 1east one question from each module.)**

MODULE I (12+4)

Design of precision machines and instruments: Basic in the design of precision machines and instruments, Mechanical design v/s Precision engineering design, Design process, Source of error in instruments, Error compensation, signal flow diagram and four quadrant diagram for instruments, precision design consideration in machine frames, Sliding and rolling element bearings.

MODULE II (12+4)

Precision manufacturing: revew of non conventional production techniques-spark erosion, electrochemical operation: ultrasonic and abrasive. Introduction to Micro & Nano machining, Precision manufacturing processes v/s Extrude honing: Magnetic abrasive machining; Water jet machining, electrochemical machining, Etching and joining technique for electrical components, Sensors and Controls in manufacturing.

MODULE III (12+4)

Precision Metrology; Analog and digital measuring techniques, Laser Interferometry, Application of machine vision in measurements, Coordinate measurement machines (CMM), Abbe's principle, Types of CMM. Components of CMM, Measurements on CMM.

MODULE IV (12+4)

Micro engineering; Introduction to micro electro mechanical systems MEMS), Micro system technology(MST), Design of microsystem, Micro sensors and micro actuators, piezo electric actuators, magneto strictive actuators shape memory alloys (SMA)

TEXTBOOKS

1. Alexander H. Slocum, Precision Machine Design. Prentice Hall, 1992
2. Raman R: Elements of Precision Engineering.

REFERENCE

1. **Davidson A: Handbook on Precision Engineering**

ME 8. 4. 2: ADVANCED METAL FORMING

	L +T+P
Lectures/Tutorials/Practical's per week	**: 3+1+2**
Question Paper Duration	**: 3 Hrs**
Max marks for theory paper	**: 100**
Max. marks for sessionals	**: 25**
Max. marks for orals	**: 50**
Total no. of questions from each module	**: 2**
Total no of questions to be answered	**: 5 (At 1east one question from each module.)**

MODULE –1 (15+5)

Introduction to analysis of metal forming process and its usefulness in the industry. Introduction to the theory of plasticity, Stress and its components, Stress-Strain and Stress-strain analysis, Plane strain and Plane-Stress analysis and its application. Axisymmetric compression.

MODULE – 2 (12+4)

Introduction to metal forming Processes. Cold and Hot forming

Rolling: Layout of tropical rolling mills, Sequences of operations, time cycles, Productivity, Economical indices, Defect in rolling, Main parameters in rolling. Rolling mills equipments.

MODULE – 3 (9+3)

Forging: Forging operations are the technology of hammer forging presses. Inspection and tolerances in forging. Forging equipments.

MODULE – 4 (12+4)

Extrusion: Parameters in hot and cold extrusion, metal flow, selection of presses, extraction equipment.

Wire Drawing: Principals and parameters, Technology of various operations.

TEXT BOOKS

1. Rawe G.W, introduction to the principle of Metal working, Edwarded Arnold Publishers, London.
2. Avitzur B, Metal forming Processor and analysis, McGraw Hill, New York, 1958.

REFERENCE

1. Johnson W and Mellor P b, Plasticity for Mechanical engineers, Van Nostrant, London, 1972.

ME 8.4.3: Supply Chain Management

	L +T+P
Lectures/Tutorials/Practical's per week	**: 3+1+2**
Question Paper Duration	**: 3 Hrs**
Max marks for theory paper	**: 100**
Max. marks for sessionals	**: 25**
Max. marks for orals	**: 50**
Total no. of questions from each module	**: 2**
Total no of questions to be answered	**: 5 (At 1east one question from each module.)**

Course Objectives:

Supply Chain Management (SCM) is about the management of material and information flows in multi-stage production distribution networks. Intense and fierce global competition and advances in information Technology have motivated companies to take initiatives to reduce costs and increase responsiveness to changes in the marketplace.

Instructional Objectives:

This course will provide students with the knowledge and tools necessary to develop, implement and sustain strategies for managing supply chains.

MODULE I.

(12+4)

Introduction to Supply Chain Management (SCM), Classification of Inventory Systems. Basics of SCM,. Managing Supply Chain inventory - pitfalls and opportunities. Planning demand and supply in Supply Chains, Managing economy of scale and uncertainty in Supply Chains, Lead times, Understanding impact of uncertainty of demand and supply on supply chains.

MODULEII

(12+4)

Supply Chain design appropriate for mass customization. Design for localization and Design for customization. Managing transportation in Supply Chains, links between transportation and inventory costs in the design of transportation networks, Issues in facility location in Supply Chains.

MODULE III (12+4)

Network Design in Supply Chains, framework for facility location decisions. Operational issues in Supply Chains, effect of demand and lead time uncertainty on the total costs of the Supply Chains. Playing the Beer Distribution game of the Supply Chain of the retailer, distributor, wholesaler and the manufacturer of a beer distribution Supply Chain. Information Distortion / Bullwhip Effect in Supply Chains. Different performance measures of Supply Chains.

MODULE IV (12+4)

Information technology and E-business in Supply Chain Management. Impact on sourcing of raw materials, distribution etc.

Studying and analyzing the supply chains of local industries like mining, tourism etc. and identifying the strong and weak points of each. Case studies of supply chains of the UP DeskJet, Dell Computers or any other major companies and one or two local industries.

TEXT BOOKS

1. Sunil Chopra, Peter Meindl,: Supply Chain Management - Strategy, Planning and Operations, Pearson Education Asia.

2. Simchi-Levi, Kaminsky, Simchi-Levi :Designing and Managing the Supply Chain, ,

McGraw Hill International edition.

3. Alterkar: Supply Chain Management , Concepts and Cases, Prentice Hall of India

REFERENCES:

1. G. Raghuram and N.Rangaraj (Ed.): Logistics and Supply Chain Management - Cases and Concepts, McMillan India Ltd, New Delhi.

2. Harvey M. Wagner: Principles of Operations Research - with applications to managerial decisions, Prentice Hall India Ltd., New Delhi.

3. Douglas Lambert, James Stock and Lisa Ellram, Irwin :Logistics Management -McGraw Hill International edition

ME 8. 4. 4: LOW COST AUTOMATION

	L +T+P
Lectures/Tutorials/Practical's per week	**: 3+1+2**
Question Paper Duration	**: 3 Hrs**
Max marks for theory paper	**: 100**
Max. marks for sessionals	**: 25**
Max. marks for orals	**: 50**
Total no. of questions from each module	**: 2**
Total no of questions to be answered	**: 5 (At 1east one question from each module.)**

Course Objectives: To know various low cost automation System and it application in industry. The student as mechanical Engineer should be able to design, Hydraulic, Pneumatic circuits and to control them.

Instructional Objectives: Student is required to be exposed to basics of Hydraulic, Pneumatics and PLC's microprocessor before entering in to design of Pneumatic, hydraulic circuits and to use this in various application in Industry.

MODULE – I

(12+4)

Automation

Introduction, Mechanization vs Automation, Application of Automation, Goals of automation social issues of Automation Low cost Automation. Types of Automation, current emphasis on automation, Reasons for automation, Issues for automation in factory operation. Ten strategies for automation.

Synthesis of Automatic systems- Basic concepts. Types of system comparison

Planning for Low Cost Automation, Mechanism for Low Cost Automation, Mechanical system for working cycle.

MODULE – II

(12+4)

Pneumatics – Elements, Pneumatic circuits, Electropneumatics.

Advantages and disadvantages of Pneumatic

Application of Pneumatics

Pneumatic Logic Circuits.

Hydraulic system Elements, Synthesis or circuits, Baisc Hydraulic system and Hydraulic system Design, some typical applications, Hydraulic servosystem.

Advantages & disadvantages if Hydraulics fluids used in Hydraulics rules for working with Hydraulics

MODULE – III

(12+4)

Fluidics:

Introduction Boolean Algebra, Laws of Boolean Algebra, Truth Table, Logic Gates, Origin and Development of fluidics, Coanda's Effact, Fluid Devices, Fluidic Sensors, Fluidic Amplifier, Advantages of fluidics.

Electrical and Electronic controls:

Sensors and Transducers, Senior Terminology, selection of a Transducer Photoelectric sensors LVDT/RVDT, Photoresistors, Microphone/speaker, piezoelectric devices ,Magnetostrictive Transducer, Pressure Transducer Strain gauges.

MODULE IV

(12+4)

Introduction to Microprocessor, Its design and Architecture Components of a microprocessor, How Microprocessor works, Classification of Microprocessor, Application of Microprocessor Programmable Logic Controller(PLC)

Control programme, Advantages of PLC,

Control program, Advantages of PLC, working of PLC, PLC Programming,

Transfer Devices and Feeders

Introduction fundamentals of production line, types of Assembly lines, Transfer systems, Mechanisms Transfer devices/Machines. Types of Transfer Devices. Transfer Devices used in Transfer machines. Advantages and Disadvantages of Transfer Machines.

Classification of feeders, Criteria for material selection of feeder, Parts feeding Devices, Types of Feeders

TEXT BOOKS

1. Industrial Automation and Robotics by A. K. Gupta & S. K. Arora
2. Low Cost Automation – Report on short term course on Low Cost Automation by IIT Bombay, 1986

REFERENCE:

Mechatronics by Prof C. R. Venkatramana, Sapna Book House Banglore.

ME 8.4.5: FLUID POWER CONTROL

	L +T+P
Lectures/Tutorials/Practical's per week	**: 3+1+2**
Question Paper Duration	**: 3 Hrs**
Max marks for theory paper	**: 100**
Max. marks for sessionals	**: 25**
Max. marks for orals	**: 50**
Total no. of questions from each module	**: 2**
Total no of questions to be answered	**: 5 (At 1east one question from each module.)**

Course Objectives:

This is an interdisciplinary course with application of knowledge from the basic subjects of applied mechanics, fluid mechanics, turbo machineries and mechatronics. This course meets the basic requirement of industry who require engineers to implement low cost automation.

Instructional Objectives:

Fluid Power control focuses on analyses applied to hydraulics and pneumatics. Components of hydraulics. Components of hydraulics and pneumatics are then discussed prior to application circuits. Programming circuits. Programmable logic controllers are also discussed in brief.

MODULE I

Introduction to fluid Power: advantages & application of fluid Power systems, Components of fluid power system, Types of fluid power control system, Environmental Issues.
(2+0)

Physical Properties of Hydraulic Fluids – Pascal's law, Bulk Modulus, viscosity & Viscosity Index. (2+1)

Energy and Power in Hydraulic Systems: Application of Pascal's Law, Conservation of Energy, The Continuity Equation, Bernoulli's Equation, Torricelli's theorem.
(4+1)

Hydraulic Conductors and Fittings: Conductor Sizing for Flow Rate Requirements, Pressure Rating of Conductors, Steel Pipes, Steel Tubing, Plastic Tubing, Flexible Hoses, Metric Steel Tubing. (4+2)

MODULE II

Basics of Hydraulic Flow in Pipelines : Frictional losses in Laminar and Turbulent Flow, Losses in Valves and Fittings, Equivalent Length technique, Hydraulic Circuit Analysis. (3+1)

Hydraulic Pumps: Pumping theory, Classification of pumps, Gear pumps, Vane pumps, Piston pumps, Pump Performance, Pump Selection, Pump Noise. (3+0)

Hydraulic Actuators and Motors: Linear Hydraulic Actuators, Mechanics of Hydraulic Cylinders loadings, Limited Rotation Hydraulic Actuators, Gear Motors, Vane Motors, Piston Motors, Hydraulic Motor Performance, Hydrostatic Transmissions. (3+1)

Hydraulic Direction Control: Check Valves, Shuttle Valves, 2 Way, 3 Way and 4 Way Direction Control Valves, Direction Control Valve Actuation, Hydraulic Circuits, Specifications. (3+2)

MODULE III

Hydraulic Pressure Control: Pressure Relief Valves, Unloading Valves, Pressure Reducing Valves, Sequence Valves, Counterbalance Valves, Brake Valves, Pressure Compensated Pumps, Specifications. (3+2)

Hydraulic Flow Control : Flow Valve Control Valve types, Flow Coefficient, Circuits, Cushioned Cylinders, Flow Dividers, Specifications. (3+0)

Ancillary Hydraulic Components : Accumulators, Intensifiers, Reservoirs, Filters, Seals and Bearing. (3+2)

Electronic Controls for Fluid Power: Solenoid Valves, Proportional and Servo Valves, Pump Controls. (3+0)

MODULE IV

Pneumatics : Introduction, Gas laws, Gas Flow, Vacuum , Pneumatic Systems. (2+0)

Pneumatic Power Supply : Compressor Types, Compressor Sizing, Vacuum Pumps. (2+1)

Pneumatic Components: Pneumatic Cylinders, Pneumatic Motors, Pneumatic Direction Control Valves, Pneumatic Flow Valve Control Valves, Air Preparation, Air Distribution.

(4+1)

Fluid Logic Control Systems: Moving Part Logic Control Systems, Principles of Fluidic Logic Control, Basic Fluidic Devices, Fluidic Sensors, Fluidic Control of Fluid Power Systems, Introduction to Boolean Algebra, Examples using Boolean Algebra.

(4+2)

TEXT BOOKS :

1. Anthony Esposito : Fluid Power with Applications, Prentice Hall.
2. James L. Johnson : Introduction to Fluid Power, Delmar Thomson Learning.
3. S. Illango , V Soundararajan Introduction to Fluid Power , Prentice Hall of India.

REFERENCES :

1. Peter Rohner : Fluid Power Logic Circuit Design, McMillan Press.
2. John Pippenger, Tyler Hicks: Industrial Hydraulics, McGraw Hill Industrial Editions.
3. Bolton W., Pneumatic and Hydraulic Systems, Butterworth-Heinemann.

ME 8.4.6: NANOTECHNOLOGY

	L +T+P
Lectures/Tutorials/Practical's per week	**: 3+1+2**
Question Paper Duration	**: 3 Hrs**
Max marks for theory paper	**: 100**
Max. marks for sessionals	**: 25**
Max. marks for orals	**: 50**
Total no. of questions from each module	**: 2**
Total no of questions to be answered	**: 5 (At 1east one question from each module.)**

Course Objectives:

This course explores the basic principles associated with nanoscience and nanotechnology including the fabrications & synthesis, size dependent properties, characterization and application of materials at nanometer length scales with an emphasis on recent technological breakthroughs in the field.

Instructional Objectives:

- **To describe method for fabricating nanoparticles, nanotubes, nanowires, and nanostructured thin films.**
- **To understand the physical properties of nanomaterials.**
- **To understand tools for structure and property characterization of nanostructures.**
- **Be knowledge in the various modern technologies used in nanotechnology to grow bulk crystals, thin films, and nanoscale structures.**
- **To understand applications for nanomaterials.**
- **To use literature resources for further self-guided learning about nanoscale materials.**

MODULE I (12+4)

1. **Introduction: Background and Defination of Nanotechnology, Emergence of Nanotechnology, Bottom-Up and Top-Down Approaches, Challenges in Nanotechnology, Applications in Different Fields, Reliability Issues of MEMS/NEMS**

2. **Zero-Dimensional Nanostructures – Nanoparticles: Introduction, Nanoparticles through Homogeneous Nucleation, Nanoparticles through Heterogeneous**

MODULE II (12+4)

3. **One-dimensional Nanostructres – Nanowires and Nanorods: Introduction, Spontaneous Growth, Template-Based synthesis, Electrospinning. Lithography.**
4. **Two-dimensional Nanostructures – thin Films: fundamentals of Film Growth vacuum Science, Physical Vapor Deposition(PVD), Chemical Vapor Deposition (CVD), Atomic Layer Deposition(ALD), Superlattices, Self Assembly, Langmuir – Blodgett Films, electrochemical Deposition, Sol-Gel Films**

MODULE III (12+4)

5. **Special Nanomaterials: Introduction, Carbon Fullerenes and Nanotubes, Micro and Mesoporous Materials, Core-Shell Structures, Organic-Inorganic Hybrids, Intercalation Compounds, Nanocomposites and Nanograined Materials**
6. **Nanostructures Fabricated by Physical Techniques: Introduction, Lithography, Nanomanipulation and Nanolothography, Soft lithography, assembly of Nanoparticles and Nanowires, Other methods for microfabrication.**

MODULE IV (12+4)

7. **Characterization and Properties of Nanomaterials: Introduction, Structural Characterization, chemical Characterization, physical Properties of Nanomaterials-Electrical conductivity, Ferroelectrics and dielectrics, Superparamagnetism.**
8. **Application of Nanomaterials: Introduction, Molecular electronics and Nanoparticles, Nanobots, Biological applications of Nanoparticles, Catalysis by Gold Nanoparticles, Band Gap Engineered Quantum Devices, Nanomechanics, Carbon Nanotube Emitters, Photoelectrochemical Cells, Photonic Crystals and Plasmon Waveguides**

Text Books:

1. Nanostructures and nanomaterials Synthesis, properties & applications Guozhong Gao, Imperial College Press London
2. Introduction to Nanotechnology – Charles P. Poole Jr. and Franks. J. Qwe4ns, John Wiley & Sons, Inc., New Jersey
3. Nano Materials A. K. Bandyopadhyay, New Age Publishers
4. Springer Handbook of Nanotechnology – Bharat Bhusan. Springer-Verlag Berlin Germany

References:

1. Hand book of Nano science, Engineering and Technology- Willam A Goddard Donald W. Brenner, Sergy E. Leshevsky. Gerald j. Jafrate, CRC Press, New York
2. Nanomaterials: Mechanics and Mechanisms – K. T. Ramesh, Springer science+Business Media, New York.