Mechanical Engineering (ME)

EN010301A ENGINEERING MATHEMATICS II
(Common to all branches except CS & IT)

Teaching scheme **Credits: 4**

2 hours lecture and 2 hour tutorial per week

Objectives

- *To apply standard methods and basic numerical techniques for solving problems and to know the importance of learning theories in Mathematics.*

MODULE 1 Vector differential calculus (12 hours)

Scalar and vector fields – gradient-physical meaning- directional derivative-divergence an curl - physical meaning-scalar potential conservative field- identities - simple problems

MODULE 2 Vector integral calculus (12 hours)

Line integral - work done by a force along a path-surface and volume integral-application of Greens theorem, Stokes theorem and Gauss divergence theorem

MODULE 3 Finite differences (12 hours)

Finite difference operators Δ, ∇, E, μ and δ - interpolation using Newtons forward and backward formula – problems using Stirlings formula, Lagrange's formula and Newton's divided difference formula

MODULE 4 Difference Calculus (12 hours)

Numerical differentiation using Newtons forward and backward formula – Numerical integration – Newton's – cotes formula – Trapezoidal rule – Simpsons $1/3^{rd}$ and $3/8^{th}$ rule – Difference equations – solution of difference equation

MODULE 5 **Z** transforms (12 hours)

Definition of Z transforms – transform of polynomial function and trignometric functions – shifting property , convolution property - inverse transformation – solution of 1^{st} and 2^{nd} order difference equations with constant coifficients using Z transforms.

Reference

1. Erwin Kreyszing – Advance Engg. Mathematics – Wiley Eastern Ltd.
2. B.S. Grewal – Higher Engg. Mathematics - Khanna Publishers
3. B.V. Ramana - Higher Engg. Mathematics – McGraw Hill
4. K Venkataraman- Numerical methods in science and Engg -National publishing co
5. S.S Sastry - Introductory methods of Numerical Analysis -PHI
6. T.Veerarajan and T.Ramachandran- Numerical Methods- McGraw Hill
7. Babu Ram – Engg. Mathematics -Pearson.
8. H.C.Taneja Advanced Engg. Mathematics Vol I – I.K.International

EN010 302 Economics and Communication Skills

(Common to all branches)

Teaching scheme
2hours lecture and 2 hours tutorial per week **Credits: 4(3+1)**
Objectives

- To impart a sound knowledge of the fundamentals of Economics.

Economics

Module I (7 hours)
Reserve Bank of India-functions-credit control-quantitative and qualitative techniques
Commercial banks-functions- Role of Small Industries Development Bank of India and National Bank for Agriculture and Rural Development
The stock market-functions-problems faced by the stock market in India-mutual funds

Module II (6 hours)
Multinational corporations in India-impact of MNC's in the Indian economy
Globalisation-necessity-consequences
Privatisation-reasons-disinvestment of public sector undertakings
The information technology industry in India-future prospects
Module III (6 hours)
Direct and indirect taxes- impact and incidence- merits of direct and indirect taxes-progressive and regressive taxes-canons of taxation-functions of tax system-
tax evasion-reasons for tax evasion in India-consequences-steps to control tax evasion
Deficit financing-role-problems associated with deficit financing

Module IV (5 hours)
National income-concepts-GNP, NNP, NI, PI and DPI-methods of estimating national income-difficulties in estimating national income
Inflation-demand pull and cost push-effects of inflation-government measures to control inflation

Module V (6 hours)
International trade-case for free trade-case for protectionism
Balance of payments-causes of disequilibrium in India's BOP-General Agreement on Tariffs and Trade-effect of TRIPS and TRIMS in the Indian economy-impact of WTO decisions on Indian industry

Text Books

1. Ruddar Datt, Indian Economy, S.Chand and Company Ltd.
2. K.K.Dewett, Modern Economic Theory, S.Chand and Company Ltd.

References

1. Paul Samuelson, Economics, Tata McGraw Hill
2. Terence Byres, The Indian Economy, Oxford University Press
3. S.K.Ray, The Indian economy, Prentice Hall of India
4. Campbell McConnel, Economics, Tata McGraw Hill

Communication Skills

Objectives

- To improve Language Proficiency of the Engineering students
- To enable them to express themselves fluently and appropriately in social and professional contexts
- To equip them with the components of different forms of writing

MODULE – 1 (15 hours)

INTRODUCTION TO COMMUNICATION

Communication nature and process, Types of communication - Verbal and Non verbal, Communication Flow-Upward, Downward and Horizontal, Importance of communication skills in society, Listening skills, Reading comprehension, Presentation Techniques, Group Discussion, Interview skills, Soft skills

MODULE – II (15 hours)

TECHNICAL COMMUNICATION

Technical writing skills- Vocabulary enhancement-synonyms, Word Formation-suffix, affix, prefix, Business letters, Emails, Job Application, Curriculum Vitae, Report writing-Types of reports

Note: No university examination for communication skills. There will be internal evaluation for 1 credit.

REFERENCES

1. The functional aspects of communication skills, P.Prasad and Rajendra K. Sharma, S.K. Kataria and sons, 2007
2. Communication skills for Engineers and Scientists, Sangeeta Sharma and Binod Mishra, PHI Learning private limited, 2010
3. Professional Communication, Kumkum Bhardwaj, I.K. International (P) House limited, 2008
4. English for technical Communication, Aysha Viswamohan, Tata Mc Graw Publishing company limited, 2008

ME010 303: Fluid Mechanics

(Common with AN010 303 & PE010 303)

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Objectives

- *To impart the basic concepts of fluid mechanics by providing exposure to diverse real world engineering examples.*
- *To develop understanding about basic laws and equations used for analysis of static and dynamic fluids.*

Module I (15 hours)

Introduction and basic concepts-properties of fluids-density, specific gravity, specific weight, specific volume, capillarity, surface tension, compressibility, bulk modulus, viscosity-Newtonian and non Newtonian fluids.

Fluid statics: pressure-variation of pressure-absolute and guage pressure- Pascal's law, manometers- hydrostatic force on plane and curved surfaces-buoyancy and floatation-stability of submerged and floating bodies-metacentric height.

Module II (12 hours)

Euler's momentum equation-Bernoulli's equation and its limitations-momentum and energy correction factors-applications of Bernoulli's equation-venturimeter, orifice meter, pitot tube, orifices and mouthpieces, notches and weirs-rotameter.

Module III (10 hours)

Flow through pipes-laminar and turbulent flow in pipes-critical Reylond's number- Darcy Weisbach equation-hydraulic radius-power transmission through pipes-losses in pipes-pipes in series pipes in parallel-hydraulic gradient line and total energy line-equivalent pipe--moody's diagram-water hammer.

Open channel flow-Chezy's equation-most economical cross section-hydraulic jump.

Module IV (12 hours)

Fluid kinematics-Eulerian and Lagrangian approaches-classification of fluid flow-graphical description of flow pattern-stream lines, path lines, streak lines, stream tubes-velocity and acceleration in fluid flow-continuity equation.

Ideal fluids-rotational and irrotational flow-circulation and vorticity-potential function and stream function, basic flow fields-uniform flow. Source, sink, doublet, vortex, spiral flow, flow past a cylinder with circulation-Magnus effect-Joukowski theorem.

Module V (11 hours)

Boundary layer-boundary layer flow theory- boundary layer over flat plate- boundary layer thickness-displacement, momentum and energy thickness-boundary layer separation-methods of controlling-wake-drag force on a rectangular plate-pressure drag-friction drag-total drag-streamlined body-bluff body, lift and drag force on an aerofoil-characteristics-work done. Hagen-Poiseuille equation.

Text Books

1. Yunus A. Cengel and John M. Cimbala, *Fluid Mechanics*, Tata McGraw Hill, New Delhi
2. R.K.Rajput, *Fluid Mechanics*, S Chand and Company, New Delhi

Reference Books

1. Douglas, *Fluid Mechanics*, Pearson Education, New Delhi
2. Shames I.H, *Fluid Mechanics*, Tata McGraw Hill, New Delhi
3. D. S .Kumar , *Fluid Mechanics*, S. K. Kataria & Sons, New Delhi
4. White F.M, *Fluid Mechanics*, Tata McGraw Hill, New Delhi
5. S. K. Som & G Biswas, *Fluid Mechanics*, Tata McGraw Hill, New Delhi
6. R. K. Bhansal, *Fluid Mechanics& Hydraulic Machines*, Laxmi Publications, New Delhi
7. B.S Massey, *Fluid Mechanics*, Tata McGraw Hill, New Delhi
8. Mody & Seth, *Fluid Mechanics& Hydraulic Machines*, Laxmi Publications, New Delhi
9. F.M. Streeter, *Fluid Mechanics*, Tata McGraw Hill, New Delhi
10. Jagdishlal , *Fluid Mechanics & Hydraulics*, Metropolitan Book Co., New Delhi

ME010 304: Metallurgy and Material Science

(Common with PE010 304 and AU010 304)

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To provide physical concepts of atomic radius, atomic structure, chemical bonds, crystal structure, grain size, work hardening,, heat treatment etc. of metals with mechanical behaviour.*
- *To understand the causes of metal failure and deformation*
- *To determine properties of unknown materials and develop an awareness to apply this knowledge in material design.*

Module 1 (12 hours)

Atomic structure:- Correlation of atomic radius to strength, electron configurations (basic only) - **Primary bonds**:- Covalent and Ionic bond: bond energy with strength, cohesive force, density, directional and non-directional bonding; Metallic bond: conductivity, ductility, opaque, lustrous, density, non directional bonding – **Specific properties of bonding**:- Deeper energy well bond and shallow energy well bond, melting temperature, modulus of elasticity, coefficient of thermal expansion and attributes of modulus of elasticity in metal cutting process - **Secondary bonds:-** classification, hydrogen bond, specific heat etc.

Crystallography:- Crystal, space lattice, unit cell - BCC, FCC, HCP structures - short and long range order - Effects of crystalline and amorphous structure on mechanical properties - Determination of atomic packing factor of SC, BCC, FCC, coordination number; densities - Polymorphism and allotropy - **Miller Indices:-** slip system, brittleness of BCC, HCP and ductility of FCC - **Modes of plastic deformation:-** Slip, twinning, Schmid's law, correlation of slip system with slip in metals.

Module 2 (12 hours)

Classification of crystal imperfections: - types of **dislocation**, source of dislocation, cross slip, climb, jog, kink, forest of dislocation, role of surface defects on crack initiation - Burgers vector - Correlation of dislocation density with strength and nano concept - Significance of **Frank and Read source** in metals deformation - **Mechanism of crystallization:** Homogeneous and heterogeneous nuclei formation, under cooling, dendritic growth, grain boundary irregularity - Effects of grain size, grain size distribution, grain shape, grain orientation on dislocation/strength and creep resistance - Hall - Petch equation; significance high and low angle grain boundaries on dislocation - – polishing and etching to determine the microstructure - crystal structure determination by **X - ray diffraction** method - ***Diffusion*** in solids, fick's laws, mechanisms, applications of diffusion in mechanical engineering.

Module 3 (12 hours)

Phase diagrams: - Limitations of pure metals and need of alloying - classification of alloys, solid solutions, Hume Rothery`s rule - single phase, multi-phase equilibrium diagrams - lever rule and Gibb`s phase rule - Coring - Equilibrium diagrams reactions:- monotectic, eutectic, eutectoid, peritectic, peritectoid - Detailed discussion on **Iron-Carbon equilibrium diagram** with **microstructure** and properties changes in austenite, ledeburite, ferrite, cementite, interlamellar spacing of pearlite to strength etc, special features of martensite transformation, bainite, spheroidite etc..

Heat treatment:- Definition and necessity - TTT diagrams - critical cooling rate (CCT) - annealing, normalizing, hardening, spheroidizing - Tempering:- austermpering, martempering and ausforming - Hardenability, Jominy end quench test, applications – hardness and micro-hardness tests - **surface hardening methods**:- carburizing processes; Nitriding; Flame, induction, laser and electron beam hardening processes; applications - **Types of Strengthening mechanisms:-** grain size reduction, work hardening, Solid solution hardening, precipitation strengthening and over ageing, dispersion hardening - **Cold working**: Detailed discussion on strain hardening; recovery; re-crystallization, effect of stored energy; re-

crystallization temperature, effect of grain size; driving force for grain growth - **hot working** - Bauschiner effect and attributes in metal forming.

Module 4 (12 hours)

Alloy steels:- Effects of alloying elements on: dislocation movement, polymorphic transformation temperature, formation and stability of carbides, grain growth, displacement of the eutectoid point, retardation of the transformation rates, improvement in corrosion resistance, mechanical properties – Nickel steels, Chromium steels etc. - Enhancement of **steel properties** by **adding alloying elements:-** Molybdenum, Nickel, Chromium, Vanadium, Tungsten, Cobalt, Silicon, Copper and Lead – **High speed steels:-** Mo and W types, effect of different alloying elements in HSS - **Cast irons**: Classifications, grey, white, malleable and spheroidal graphite cast iron, composition, microstructure, properties and applications – Principal **Non ferrous Alloys: -** Aluminum, Copper, Magnesium, Nickel, Titanium, study of composition, microstructure, properties, applications, reference shall be made to the phase diagrams whenever necessary.

Module 5 (12 hours)

Fracture: – Brittle and ductile fracture - Griffith theory of brittle fracture - stress concentration, stress raiser – Effect of plastic deformation on crack propagation – transgranular, intergranular fracture - Effect of impact loading on ductile material and its application in forging etc.- **Fatigue**:- Stress cycles – Primary and secondary stress raisers - Characteristics of fatigue failure, S-N curve - Factors affecting fatigue strength: stress concentration, size effect, surface roughness, change in surface properties, surface residual stress -Ways to improve fatigue life – effect of temperature on fatigue, thermal fatigue and its applications in metal cutting – Mechanism of fatigue failure – structural features of fatigue:- crack initiation, growth, propagation – fatigue tests - Fracture toughness (definition only) - Ductile to brittle transition temperature **(DBTT)** in steels - **Creep**:- Creep curves – creep tests- Structural change:- deformation by slip, sub-grain formation, grain boundary sliding – Mechanism of creep deformation - threshold for creep - prevention against creep- **Super plasticity:** applications.

Text Books

1.Introduction to Physical Metallurgy – Tata McGraw Hill.
2.Callister William. D. – Material Science and Engineering – John Wiley.
3.Dieter George E. – Mechanical Metallurgy – McGraw Hill.
4.Higgins R.A. – Engineering Metallurgy part - I – ELBS.
5.Raghavan V. - Material Science and Engineering - Prentice Hall.
6. Van Vlack – Elements of Material Science - Addison Wesley.

Reference Books

1.Anderson J.C. *et.al*. – Material Science for Engineers – Chapman and Hall.
2.Clark and Varney - Physical metallurgy for Engineers – Van Nostrand.
3.Manas Chanda - Science to Engineering Materials - Vol I, II and III - Macmillan India.
4.Reed Hill E. Robert – Physical Metallurgy Principles – East West Press.
5.Richards C.W. – Engineering Material Science.

ME010 305: Programming in C

(Common with PE010 305 and AU010 305)

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart advanced knowledge in programming in C language*

Module I (15 hours)

Introduction to computer programming; Various I/O functions; Data types; Constants and Variables; Escape Sequences; Type Casting; Preprocessor Directive; Storage Classes; Scope of Variables; Mathematical Operators; Relational Operators; Branching Instructions; Logical Operators; Conditional Operator; Precedence of Operators; Loops – for, while and do-while, break and continue instructions, Nested Loops; Switch statement; Evaluation of e^x, sin(x), cos(x) Numerical Integration using Trapezoidal and Simpson's rules.

Module II (10 hours)

Arrays; One Dimensional Arrays; Selection Sorting; Binary Searching; Various String Handling Functions; Multidimensional Arrays; Matrix Operations (Addition, Transpose and Multiplication); Sorting of Strings; Structure and Union; Array of Structures;

Module III (10 hours)

Functions; Call by Value Method; Stack; Passing One Dimensional and Multidimensional Arrays to a Function; Recursion; Writing Different String Handling Functions Using Simple Functions and Functions with Recursive Calls; Quick Sorting; Macros; Writing Macros for Simple Operations;

Module IV (15 hours)

Declaration of Pointers; Call by Reference Method; Pointer to a Structure; Pointer to an Array; Array of Pointers; Pointer to a Pointer; Self Referential Structure; Dynamic Memory Allocation; Reallocation of Memory; Linear Linked List; Circular Linked List; Double Linked List; Addition, Insertion and Deletion of Nodes from a Linked List; Command Line Arguments

Module V (10 hours)

Different types of Files; Reading, Writing, Appending and Rewriting of Text and Binary Files; Transfer of Data in Blocks; Moving of File Pointer in a File; Usage of bitwise AND, OR, NOT, XOR, Shift Left and Shift Right Operations

Text Books

1. Bryon S.Gottfried, *Programming with C Language*.

Reference Books

1. Balaguruswamy, *Programming in ANSI C,*
2. Deitel, *How to Program C*
3. Kamthane, *Programming with ANSI and Turbo C*

ME010 306(CE) Strength of Materials & Structural Engineering

(Common with PE010 306(CE), AU010 306(CE) and PO010 306(CE))

Teaching Scheme:-

3 hours lecture and 1 hour tutorial per week **Credits**: 4

Objectives

- *To study internal effects produced and deformations of bodies caused by externally applied forces.*
- *To understand the stresses and strains in different materials and analyse strength characteristic of structural members.*

Module I (15 hours)

Introduction to analysis of deformable bodies:-
stresses due to normal, shear and bearing loads-Axial and shear strains –
Simple stresses and strains: Material behavior - uniaxial tension test - stress-strain diagrams. Hooke's law for linearly elastic isotropic material.
Elastic constants - relation between them - Bars of varying cross section -Composite sections- Equilibrium and compatibility conditions- Temperature stresses

Module II (10 hours)

Bending moment and shear force: Cantilever, simply supported and overhanging beams - concentrated and U.D loading(analytical method) Relation between load shear force and bending moment.

Module III (15 hours)

Stresses in beams: Pure bending - flexure formula for beams - assumptions and limitations -section modulus - flexural rigidity - economic sections beams of uniform strength. Shearing stress formula for beams - assumptions and limitations.
Deflection of beams: Moment-curvature relation - assumptions and limitations singularity functions - Macaulays method - moment area method for simple cases.

Module IV (10 hours)

Torsion: Torsion theory of elastic circular bars – solid and hollow shaft assumptions and limitations - polar modulus- torsional rigidity - economic cross-sections.
Pressure vessels: Thin and thick cylinders-Lame's equation-stresses in thick cylinders due to internal pressure – compound pipes.

Module V (10 hours)

Combined stresses: Principal stresses and planes-Mohr's circle representation of stress in 2D problems. Use of strain gage rosettes. Combined axial, flexural and torsional loads.
Theory of columns: Buckling theory -Euler's formula for long columns - assumptions and limitations - effect of end conditions - slenderness ratio - Rankine's formula for intermediate columns -Eccentric loading of columns - kern of a section (rectangular and circular section).

Text Books

1. Timoshenko.S.P, Strength of Materials, Part 1,D.Van Nostrand company, Inc.Newyork.
2. Bansal R.K., Strength of Materials, Lakshmi Publications, New Delhi.
3. Mott, Robert L, Applied strength of materials, 5th Edn, Prentice Hall of India.
4. Popov E.P., Engineering Mechanics of solids, Prentice Hall of India, New Delhi..

Reference Books

1. Nash.W.A , Strength of Materials, Schaum's Outlines,$th Edn, TMH
2. Gere, James M , Mechanics of Materials, Cengage Learning.
3. Shames IH , Pitarresi, James.M, Introduction to Solid Mechanics, Prentice Hall of India.

ME010 307: Computer Programming Lab

(Common with PE010 408 and AU010 307)

Objectives

- *To provide experience in programming with C language*
- *To familiarize with operating systems. file directories, editors, compilers and file managers etc.*
- *To obtain exposure to computer programming languages for technical computation like MatLab*
- *Programming experiments in C to cover control structures functions, arrays, structures, pointers and files*

i. Counting characters, lines and words
ii. Checking leap year
iii. Finding sum of digits and reversing a number
iv. Generating Prime numbers, Fibonacci numbers and Angstrom numbers
v. Sine and Cosine series generation
vi. Implementation of Numerical Integration using Simpson's and Trapezoidal rules
vii. Sorting of numbers, strings and records
viii. Matrix addition and multiplication
ix. Implementation of dynamic memory allocation
x. Implementation of linked lists
xi. Problems related to files
xii. Problems related to command line arguments

ME010 308: Fluid Mechanics Lab

(Common with AN010 308 , PE010 308 and AU010 308)

Teaching scheme **Credits:** 2

3 hours practical per week

Objectives

- *To provide exposure to the actual flow process and various instruments adopted for flow measurement .*

- Study and acquire a thorough knowledge of the various pipe fittings and plumbing tools.
- Study the use of different types of taps, valves.
- Study the various measuring instruments like gauges, pitot tube, watermeters and current meters.
- Determination of metacentric height and radius of gyration of floating bodies.
- Determination of hydraulic coefficients of orifices and mouthpieces under constant head method and time of emptying method.
- Calibration of discharge measuring equipments in closed conduits like venturimeter, orificemeter, watermeter etc.
- Calibration of discharge measuring equipments in open channel flow like rectangular and triangular notches.
- Determination of Darcy's constant and Chezy's constant for pipe flow.
- Determination of critical velocity in pipe flow.
- Determination of minor losses in pipe flow.
- Experimental verification of Bernoulli's theorem.
- Determination of Chezy's constant and Manning's number for open channel flow.
- Calibration of Plug –Sluices.

Internal Continuous Assessment *(Maximum Marks-50)*

50%-Laboratory practical and record
30%- Test/s
20%- Regularity in the class

End Semester Examination *(Maximum Marks-100)*

70% - Procedure, conducting experiment, results, tabulation, and inference
30% - Viva voce

EN010401 Engineering Mathematics III

(Common to all branches)

Teaching scheme **Credits: 4**

2 hours lecture and 2 hour tutorial per week

Objectives: *Apply standard methods of mathematical &statistical analysis*

MODULE 1 Fourier series (12 hours)

Dirichlet conditions – Fourier series with period 2 π and 2l – Half range sine and cosine series – Harmonic Analysis – r.m.s Value

MODULE 2 Fourier Transform (12 hours)

Statement of Fourier integral theorem – Fourier transforms – derivative of transforms- convolution theorem (no proof) – Parsevals identity

MODULE 3 Partial differential equations (12 hours)

Formation by eliminating arbitrary constants and arbitrary functions – solution of Lagrange's equation – Charpits method –solution of Homogeneous partical differential equations with constant coefficients

MODULE 4 Probability distribution (12 hours)

Concept of random variable , probability distribution – Bernoulli's trial – Discrete distribution – Binomial distribution – its mean and variance- fitting of Binominal distribution – Poisson distribution as a limiting case of Binominal distribution – its mean and variance – fitting of Poisson distribution – continuous distribution- Uniform distribution – exponential distribution – its mean and variance – Normal distribution – Standard normal curve- its properties

MODULE 5 Testing of hypothesis (12 hours)

Populations and Samples – Hypothesis – level of significance – type I and type II error – Large samples tests – test of significance for single proportion, difference of proportion, single mean, difference of mean – chi –square test for variance- F test for equality of variances for small samples

References

1. Bali& Iyengar – A text books of Engg. Mathematics – Laxmi Publications Ltd.
2. M.K. Venkataraman – Engg. Mathematics vol II 3rd year part A & B – National Publishing Co.
3. I.N. Sneddon – Elements of partial differential equations – Mc Graw Hill
4. B.V. Ramana – Higher Engg. Mathematics – Mc Graw Hill
5. Richard A Johnson – Miller Fread's probability & Statistics for Engineers- Pearson/ PHI

6. T. Veerarajan – Engg. Mathematics – Mc Graw Hill
7. G. Haribaskaran – Probability, Queueing theory and reliability Engg. – Laxmi Publications
8. V. Sundarapandian - probability ,Statistics and Queueing theory – PHI
9. H.C.Taneja – Advanced Engg. Mathematics Vol II – I.K.International
10. A.K.Mukhopadhyay-Mathematical Methods For Engineers and Physicists-I.K.International

EN010 402(ME): Principles of Management

(Common with EN010 502(ME))

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To develop an understanding of different functional areas of management.*
- *To understand the functions and duties an individual should perform in an organisation.*

Module I (12 hours)

Management Concepts: Vision, Mission, Goals and Objectives of management-MBO-Scientific management- Functions of management- Planning- Organizing- Staffing-Directing- Motivating- Communicating- Coordinating- Controlling- Authority and Responsibility- Delegation- Span of control- Organizational structure- Line, Line and staff and Functional relationship.

Module II (12 hours)

Personnel Management: Definition and concept- Objectives of personnel management-Manpower planning- Recruitment and Selection of manpower- Training and development of manpower- Labour welfare- Labour turnover- Quality circle- Industrial fatigue- Industrial disputes-Method of settling disputes- Trade unions.

Module III (12 hours)

Production management: Objectives and scope of production management- Functions of production department- production management frame work- product life cycle-Types of production- Production procedure- Project planning with CPM and PERT- Basic concepts in network.

Module IV (12 hours)

Financial Management: Objectives and Functions of Financial Management- Types of Capital- Factors affecting working capital- Methods of financing.
Cost Management: Elements of cost- Components of cost- Selling Price of a product.

Module V (12 hours)

Sales and Marketing Management: Sales management- Concept- Functions of sales department- Duties of sales engineer- Selling concept and Marketing concept- Marketing-Definition and principles of marketing- Marketing management and its functions- Sales forecasting- Pricing- Advertising- Sales promotion- Channels of distribution- Market research.

Text Books

1. Koontz and Weihrich, *Essentials of Management*, Tata McGraw Hill.
2. Mahajan M., *Industrial Engineering and Production Management*, Dhanpat Rai and Co.
3. Kemthose and Deepak, *Industrial Engineering an Management*, Prentice Hall of India.

Reference Books

1. Martand Telsang, *Industrial Engineering and Production Management.*
2. Khanna O.P., *Industrial Engineering and Management*, Dhanpat Rai and Co.
3. Philip Kotler, *Marketing Management*, Prentice Hall of India.
4. Sharma S. C. & Banga T. R., *Industrial Organisation and Engineering Economics*, Khanna Publishers.
5. Prasanna Chandra, *Financial Management*, Tata McGraw Hill.

ME010 403: Hydraulic Machines

(Common with PE010 403)

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart knowledge regarding principles and operations of various hydraulic machines.*

Module I (12 hours)

Dynamic Action of Fluid*:* Impulse Momentum equation- applications– impact of jet – flow of an incompressible fluid over fixed and moving vanes – workdone and efficiency – reaction principle – propulsion of ships. Basic equation of energy transfer in rotodynamic machines- components of energy transfer-Classification-Axial flow, radial flow, impulse and reaction machines.

Module II (12 hours)

Hydraulic turbines*:* Classification-– impulse and reaction turbines – Euler`s turbine equation- velocity triangles - Pelton wheel, Francis turbine Kaplan turbine – construction features and performance characteristics – theory of draft tube – speed regulation of turbines – run away speed- selection, type and speed of turbines

Module III (12 hours)

Pumping machinery*:* General classification –Rotodynamic pumps - construction features- classification of impellers, impeller shapes – types of casings -working of centrifugal pumps, priming, Euler`s head equation – velocity triangles – losses, head and efficiencies– performance pump characteristics: main, operating characteristics curves- selection of pumps from performance curves – $NPSH_{required}$– $NPSH_{available}$– multistage pumps – pumps in parallel & series operation- propeller pumps.

Module IV (12 hours)

Dimensional analysis – Rayleigh' s method – Buckingham's Pi theorem – non diamesional parameters in fluid mechanics and fluid machinery – principle of similitude, geometric, kinematic and dynamic similarity – model studies. Non dimensional numbers (Reynold's number, Froude's number, Euler's number, Weber's number and Mach's number) Non dimensional parameters for incompressible flow machines –Capacity coefficient, Head coefficient, Power coefficient, Reynolds number, shape number, specific speed – Non dimensional performance curves for pumps- effect of change of outlet vane angle, impeller diameters and speed–Principle of similitude- Non dimensional parameters for comparative study of turbine performance – unit speed, unit power, unit quantity, geometric similarity – model laws – effect of specific speed on runner speed, runner size, flow type etc. Cavitation in fluid machines – installations susceptible to cavitation – collapse of bubble theory – Thoma`s prameter – factors affecting cavitation in pumps and turbines –prevention of cavitation damage.

Module V (12 hours)

Positive displacement pumps*:* reciprocating pump, effect of vapour pressure on lifting of liquid – indicator diagram – acceleration head – effect of friction – use of air vessels – work saved – Slip - efficiency – pump characteristics – applications.

Theory & application of self-priming pump, jet pump, airlift or compressor pump, slurry pump, hydraulic ram - Positive displacement Rotary pumps*:* Gear, screw, vane pumps.

Hydraulic accumulator, intensifier, fluid coupling & lift – principle of operation- hydraulic cranes, hydraulic press- Hydraulic symbols (Description only, no problems).

Text Books

1. Jagadishlal, *Hydraulic Machines*, Metropolitan Publishers.

Reference Books

1. Abdulla Sheriff ,*Hydraulic machines*, standard publishers.
2. Govinda Rao N. S, *Fluid flows machines*, TMH.
3. Pippinger, *Industrial hydraulics*.
4. Stepanoff John A. J, *Centrifugal and axial flow pumps*, iley & sons
5. Lewitt E. H, *Hydraulic & Fluid Mechanics*
6. Som S K and Biswas G, *Introduction to fluid mechanics and fluid machines*, TMH.
7. Yahya S M, *Turbines fans and compressors*, TMH.
8. R.K.Rajput, *Hydraulic Machines*, S.Chand & Company.
9. Modi & Seth, *Hydraulic Machines*, Laxmi Publications, New Delhi

ME010 404: Manufacturing Process

(Common with AU010 404)

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

1. *To gain theoretical and practical knowledge in material casting processes and develops an understanding of the dependent and independent variables which control materials casting in a production processes.*
2. *Provide a detailed discussion on the welding process and the physics of welding. Introduce students to different welding processes weld testing and advanced processes to be able to appreciate the practical applications of welding.*
3. *The course will also provide methods of analysis allowing a mathematical/physical description of forming processes.*

Module I (12 hours)

Patterns: - types, allowances, color code – Molding sand**:-** constituents, types, properties, testing, types of mould, molding machines – Cores**:-** sands, types prints, machines, chaplets, forces acting on molding flasks - Gating system**:-** fluid flow and heat transfer in metal casting, elements and design of gating system, sprue, gating ratio, slag trap system – Risering:- risering design, chills, feeding devices - Cupola operation -pouring and cleaning of castings - defects in castings - inspection and quality control - Casting**:-** continuous, strip, shell mold, vacuum, investment, slush, pressure, die, centrifugal, precision investment, squeeze casting and semi solid metal forming, economics and surface finish obtainable - casting machines - comparison of casting with other production processes. (Include necessary figures and equations).

Module II (12 hours)

Welding**:-** diffusion, definition of welding, metallurgy of welding, applications, classification, mechanism - welding design:- effect of weld parameters on weld quality, heat input, heat flow and distortions - Gas welding:- details, equipment, fluxes and filler rods – flame cutting - Arc welding:- applications, equipment, polarity, governing factor in fusion welding - electrodes and types – TIG - GMA - CO_2 process - Submerged arc, electroslag, plasma arc and flux cored arc welding - Resistance, thermit solid state welding - Electron and laser beam welding – explosive welding - inspection and defects in welding - heat affected zone, grain size variations in joint strength - Brazing and soldering - adhesive bonding – Extrusion**:** Metal flow – mechanism and types – extrusion defects.

Module III (12 hours)

Rolling**:-** principles - types of rolls and rolling mills - mechanics of flat rolling, roll pressure distribution - neutral point - front and back tension, roll forces in hot rolling, roll torque and power, friction, deflection and flattening - friction and lubrication in metal forming - defects - hot and cold rolling - rolling machines - strip velocity and roll velocity - roll and roll pass design - theories of rolling and effect of parameters - load calculation - rolling of tubes, wheels, axles, I-beam thread, gear rolling.

Module IV 12 hours)

Forging**:-** classification - open die forging, forces and work of deformation - Forging methods analysis:- slab method only, solid cylindrical, rectangular work piece in plane strain, forging under sticking condition - deformation zone geometry – die forging:- impression, close,

coining, skew rolling etc. – defects in forging – forgeability tests – die design and materials – equipments - heating in forging - quality assurance for forging -non destructive testing - mechanics of rod and wire Drawing:- ideal deformation, ideal deformation and friction, drawing of flat strips etc – drawing defects – drawing practices.

Module V (12 hours)

Locating methods:- methods, degrees of freedom - principle of clamping:- clamping types - work holding principle – Die cutting:- Different types - shearing - types of presses –cutting action in punch and die operations – die clearances – types of die:- progressive, compound, combination die – Bending dies:- bending methods, minimum bend radius, bendability, spring back, forces, bend allowances – Forming dies:- solid form, curling, embossing, coining, bulging dies - Shear and tube spinning - High energy rate forming**:-** need, energy sources - material behavior - pneumatic, mechanical, electrohydraulic, electromagnetic, and explosive forming – Deep drawing:- deep drawability, punch forces.

Text Books

1. Manufacturing Science - Amitabha Ghosh and Ashok Kumar Mallick
2. Manufacturing Engineering and Technology - Kalapakjian and Schmid

Reference Books

1. Principles of Metal Casting - Hine and Rosenthal
2. Foundry Technology - P.R.Beeley

ME010 405: Machine Drawing

(Common with PE010 405 and AU010 405)

Teaching scheme **Credits:4**

3 hours practical and 1 hour theory per week

Objectives :

- *To impart the fundamental concepts of machine drawing.*
- *To develop primary knowledge of working drawings.*
- *To produce orthographic drawing of different machine parts.*
- *To develop skill to produce assembly drawings.*
- *To develop skill to produce detailed drawings of machines parts from assembly drawing.*

Module-1(15hrs)

Conversion of pictorial views into orthographic views-dimensioning techniques-preparation of drawing- - Limits and tolerances of machine parts - Hole system and shaft system of tolerances - Designation of fundamental deviation - Types of fits and their selection - Indication of dimensional tolerances and fits on simple machine parts - Geometrical tolerances – Recommended symbols - Indication of geometrical tolerances on simple machine parts - Surface roughness – Indication of surface finish on drawings - Preparation of shop floor drawings of simple machine parts.

Types of screw threads-different forms-conventional representation-sketching orthographic views of hexagonal bolts and nuts -dimensional drawing-square headed bolts and nuts –sketching of different types of lock nuts and locking devices- foundation bolts.

Forms of rivet heads – riveted joints-lap and butt joints with single and multiple riveting in chain and zig – zag arrangements –dimensional drawing. Sketching of conventional representation of welded joint.

Module-2 (20 hrs)

Fully dimensioned and sectional drawing of the following Joints-

knuckle joint-jib and cotter

shaft couplings-types of keys- protected types of flanged couplings-bushed pin type flexible coupling-Oldham's coupling

Pipe joints-spigot and socket joint-flanged joint-

Shaft bearings and support-Plummer block IC engine parts-piston-connecting rod

Module-3(25hrs)

Assembly and working drawings of the followingValves

-stop valve-spring loaded safety valve –dead weight safety valve-feed check valve-feed check valve

Machine elements-screw jack –lathe tool post-spindle-tailstock

Note:

- Drawing practical classes have to be conducted by using any standard CAD software and using drawing instruments in alternate weeks (3Hours) preferably for each half of the student.

  Semester End examination (3Hours) shall be conducted by using drawing instruments only
- All drawing exercises mentioned above are for class work. Additional exercises wherever necessary may be given as homework
-

References:

1. N.D.Bhatt and Panchal, *Machine Drawing*, Charator Publishing House
2. P I.Varghese, *Machine Drawing*, VIP Publishers, Thrissur
3. Ajeet Singh, *Machine Drawing*, Tata McGraw Hill Education Private Ltd
4. P.S.Gill , *Machine Drawing*, S.K.Kataria &Sons

University examination pattern

Question I: One questions of 10 marks from module-1

Question II: One questions of 30 marks out of 2 questions from module-2.

Question III:One question of 60 marks from module-3

.

ME 010 406(EE) Electrical Technology

(Common with PE010 406 (EE) and AU010 406 (EE))

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

Understanding the basic working principles of DC machines Ac machines and its drives

Module I (8 hours)

D.C. Generator - O.C.C. – Condition for self excitation – field critical resistance – critical speed - Load characteristics of generators- Losses- power flow diagram- efficiency- condition for maximum efficiency- Application.

Module II (16 hours)

D.C. Motors**:** Back emf – speed and torque equation- starting and speed control – testing of D.C. Motors – brake test – Swinburn's test- Performance characteristics of Shunt, Series and Compound motors. - Applications

Transformer – Emf equation: No load current – equivalent circuit – regulation- efficiency. Determination of regulation and efficiency from O.C. and S.C. tests – cooling of transformer. Basic principle of 3 phase transformer - Applications

Module III (13 hours)

Alternators - Construction details**:** Type – emf equation (winding factor need not be derived) – synchronous impedance – regulation by emf and mmf method.

Synchronous Motors**:** Principle of operation – method of starting.

Three phase induction motor: Production of rotating magnetic field - equivalent circuit – torque equation – torque slip characteristics – no load and blocked rotor tests – starting and speed control – Application

Single Phase motor: Different types - Application.

Module IV (13 hours)

Industrial drives – electric drives – advantages – individual drive and group drive – factors affecting choice of motor – mechanical characteristics of a.C. and D.C. motors – motors for particular application like textile mill, steel mill, paper mill, mine, hoists, crane etc. – size and rating of motor . Electric traction – Different systems of traction – comparison – track electrification – different systems – traction motor characteristics – electric braking – plugging – Dynamic and regenerative braking.

Module V (10 hours)

Power semiconductor devices: power diodes – SCR's - principle of operation of SCR's – two transistor analogy of SCR – characteristics – SCR rating (basic principle only). High frequency heating – induction and dielectric heating – resistance heating resistance welding- block schematic of resistance welding scheme.

Text Books

1. Dr. P S Bimbra, *Electrical Machinery*, Khanna Publishers
2. J B Gupta, *Electrical Machines* , S K Kataria and Sons
3. Dr. P S Bimbra, *Power Electronics*, Khanna Publishers

Reference Books

1. Alexander Langsdorf A S: Theory of AC Machinery, Mc-Graw Hill
2. Say M G: Performance and design of AC Machines, ELBS
3. Electrical machines, Drives and Power Systems: Thoedore Wildi, Pearson Ed.
4. P.C. Sen, *Thyristor DC Drives*, Wiley-Interscience Publication 1984
5. Joseph Vithayathil, *Power Electronics-Principles and applications*, TMH, 2010
6. B. K. Bose, Modern Power Electronics and A.C. Drives, PHI, 2002.
7. G.K. Dubey, *Fundamentals of Electrical Drives*, Narosa Publishing House, New Delhi,2005

ME010 407: Hydraulic Machines Laboratory

(Common with PE010 407)

Teaching scheme **Credits:** 2

3 hours practical per week

Objectives

- *To provide experience on various Hydraulic machineries.*
- *To acquaint the students with the measurement of various parameters.*

Experiments

Performance characteristic tests on Pelton wheel (Load test & best speed).
Performance characteristic tests on Francis turbine (Load test & best gate opening).
Performance characteristic tests on Kaplan turbine (Load test & best gate, vane angle opening).
Performance characteristic tests on single stage, multi stage centrifugal pumps at constant speed & at variable speed. Actual & predicted curves.
Performance characteristic tests on self-priming pump, Jet pump, Airlift pump and deep well pump
Performance characteristic tests on axial flow pump.
Performance characteristic tests on Hydraulic ram.
Performance characteristic tests on reciprocating pump at constant speed.
Performance characteristic tests on Gear pump.
Performance characteristic tests on Screw pump.

Text Books

1. Abdulla Sheriff, *Fluid Mechanics & Hydraulic Machines*: Standard Publ.
2. R.K Bansal, *Fliud Machines and Hydraulic Machines* , Lakshmi publications New Delhi

Reference Books

1. K Subramanya , *Fluid Machines and Hydraulic Machines* , TMH.
2. Govinda Rao N.S, *Fluid Flows Machines*, TMH.
3. Shiv Kumar, *Fluid Mechanics & Fluid machines* , Ane books.
4. Massey B. S, *Fluid Mechanics*, ELBS
5. Stepanoff John A. J, *Centrifugal and Axial Flow Pump*, Wiley & Sons

Internal Continuous Assessment *(Maximum Marks-50)*

50%-Laboratory practical and record
30%- Test/s
20%- Regularity in the class

End Semester Examination *(Maximum Marks-100)*

70% - Procedure, conducting experiment, results, tabulation, and inference
30% - Viva voce

ME010 408 STRENGTH OF MATERIALS LAB
(Common with PE010 307 and AU010 408)

Teaching scheme **Credits: 2**
3 hours practical per week

Objective: *To study properties of various materials*

List of Experiments

1. Tests on springs (open and close coiled)
2. Bending Test on Wooden Beams using U. T. M.
3. Verification of Clerk. Maxwell's Law of reciprocal deflection and Determination of Youngs modulus'E 'for steel.
4. Torsion Pendulum (M.S. wires. Aluminum wires and brass wires)
5. Tension test using U. T. M. on M. S. Rod, torsteel and High Tensile steel.
6. Torsion Test on M. S. Rod.
7. Shear Test on M.S. Rod.
8. Fatigue Test
9. Impact Test (Izod and Charpy)
10. Hardness Test (Brinell, Vicker's and Rebound)
11. Strut Test.

Note
All tests should be done as per relevant BIS.

References

1. Timoshenko.S.P, Strength of Materials, Part-1, D.Van Nostrand company, Inc.Newyork.
2. Bansal R.K., Strength of Materials, Lakshmi Publications, New Delhi.
3. Bhavikatti S.S , Strength of Materials, Vikas Publishing House (P) Ltd.
4. D.S. Prakash Rao, Strength of Materials, Vol. I, University Press (India) Ltd.
5. Popov E.P., Engineering Mechanics of solids, Prentice Hall of India, New Deihi.
6. Punmia B.C, Strength of Materials and Mechanics of structures, Vol.1, Lakshmi Publications, New Delhi.

EN010501A ENGINEERING MATHEMATICS IV

(Common to all branches except CS & IT)

Teaching scheme **Credits: 4**

2 hours lecture and 2 hour tutorial per week

Objectives: *Use basic numerical techniques to solve problems and provide scientific techniques to decision making problems.*

MODULE 1 Function of Complex variable (12 hours)

Analytic functions – Derivation of C.R. equations in cartision co-ordinates – harmonic and orthogonal properties – construction of analytic function given real or imaginary parts – complex potential – conformal mapping of z^2 , $\frac{1}{z}$ - Bilinear transformation – cross ratio – invariant property (no proof) – simple problems

MODULE 2 Complex integration (12 hours)

Line integral – Cauchy's integral theorem – Cauchy's integral formula – Taylor's series- Laurent's series – Zeros and singularities – types of singularities – Residues – Residue theorem – evaluation of real integrals in unit circle – contour integral in semi circle when poles lie on imaginary axis.

MODULE 3 Numerical solution of algebraic and transcendental equations (10 hours)

Successive bisection method – Regula –falsi method – Newton –Raphson method - Secant method – solution of system of linear equation by Gauss – Seidel method

MODULE 4 Numerical solution of Ordinary differential equations (10 hours)

Taylor's series method – Euler's method – modified Euler's method – Runge – Kutta method (IV order) - Milnes predictor – corrector method

MODULE 5 Linear programming problem (16 hours)

Definition of L.P.P., solution, optimal solution, degenerate solution – graphical solution –solution using simplex method (non degenerate case only) Big -M method – Duality in L.P.P. – Transportation problem –Balanced T.P. – initial solution using Vogel's approximation method - modi method (non degenerate case only)

References

1. B.V. Ramana – Higher Engg. Mathematics – Mc Graw Hill
2. M.R.Spicgel , S.Lipschutz , John J. Schiller, D.Spellman – Complex variables, schanm's outline series - Mc Graw Hill
3. S.Bathul – text book of Engg.Mathematics – Special functions and complex variables –PHI
4. B.S. Grewal – Numerical methods in Engg. and science - Khanna Publishers
5. Dr.M.K Venkataraman- Numerical methods in science and Engg -National publishing co

6. S.S Sastry - Introductory methods of Numerical Analysis -PHI
7. P.K.Gupta and D.S. Hira – Operations Research – S.Chand
8. Panneer Selvam– Operations Research – PHI
9. H.C.Taneja – Advanced Engg. Mathematics Vol II – I.K.International

ME010 502 Computer Aided Design & Manufacturing

(Common with PE010 604 and AU010 502)

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To provide a comprehensive concepts of the design aspects and its importance in computer assisted design and manufacture.*
- *To examine technologies those have been developed to automate manufacturing* operations.

Module 1 (12 hours)

Evolution of CAD/CAM and CIM, computers and workstation, elements of interactive graphics, input/ out put display, storage devices in CAD, – networking of CAD systems - 2D Graphics: line drawing algorithms, DDA line algorithm – circle drawing, bressnham`s circle drawing algorithm– 2D Transformation: translation, rotation, scaling, reflection – clipping -3D Graphics (basic only).

Module 2 (12 hours)

Geometric modeling: Wire frame, surface and solid modeling - Engineering analysis; design review and evaluation, automated drafting.

Numerical control: Need - advantages and disadvantages – classifications – Point to point, straight cut and contouring positioning - incremental and absolute systems – open loop and closed loop systems – DDA integrator and Interpolators – resolution – CNC and DNC.

Programmable Logic Controllers (PLC)**:** need – relays - logic ladder program – timers, simple problems only - Devices in N.C. systems: Driving devices - feed back devices: encoders, moire fringes, digitizer, resolver, inductosyn, and tachometer.

Module 3 (12 hours)

NC part programming: part programming fundamentals - manual programming – NC co-ordinate systems and axes – tape format – sequence number, preparatory functions, dimension words, speed word, feed world, tool world, miscellaneous functions – programming exercises.

Computer aided part programming: concept and need of CAP – CNC languages – APT language structure: geometry commands, motion commands, postprocessor commands, compilation control commands – programming exercises – programming with interactive graphics.

(At least one programming exercise should be included in the University examination)

Module 4 (12 hours)

Computer Aided Process Planning (CAPP): concepts; traditional and CAPP; automated process planning: process planning, general methodology of group technology, code

structures of variant and generative process planning methods, AI in process planning, process planning software.
Flexible Manufacturing Systems (FMS): Introduction, types, concepts, need and advantages of FMS - cellular and FMS - JIT and GT applied to FMS.

Module 5 (12 hours)

Robot Technology**:** overview, basic components - robot end effectors – sensors in robotics – control of actuators in robotic mechanisms (basic only) – control of robo joint, stepper motor, direct drive actuators – hydraulic and pneumatic systems (basic only) – robot arm kinematics, direct and inverse kinematics solution robot arm dynamics – robot applications: material transfer, machine loading and unloading, pre cutting operations, assembly, inspection and welding.

TEXT BOOKS:

1. Newman and Sproull - Principles of interactive Graphics, McGraw – Hill.
2. Yoram Koren - Numerical control of machine tools, McGraw-Hill.

REFERENCE BOOKS:

1. Craig John - Introduction to Robotics
2. Groover M.P. - CAD/CAM, PHI.
3. Hearn and Baker - Computer graphics (in C version), Prentice Hall.
4. Petruzella Frank.D. - Programmable logic controllers.
5. Jonn Craig - Introduction to Robotics

ME010 503: Advanced Mechanics of Materials

(Common with PE010 503)

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Objectives

1. *To impart concepts of stress and strain analysis in a solid.*
2. *To study the methodologies in theory of elasticity at a basic level.*
3. *To acquaint with energy methods to solve structural problems.*

Module I (12 hours)

Basic equations of Elasticity, Stress at a point with respect to a plane - normal and tangential components of stress - stress tensor - Cauchy's equations - stress transformation - principal stresses and planes - strain at a point - strain tensor - analogy between stress and strain tensors - constitutive equations - generalized Hooke's law - relation among elastic constants – equations of equilibrium -strain-displacement relations –

Module II (12 hours)

Compatibility conditions - boundary conditions - Saint Venant's principle for end effects –uniqueness condition. 2-D problems in elasticity. Plane stress and plane strain problems – Airy's stress function – solutions by polynomial method – solutions for bending of a cantilever with an end load and bending of a beam under uniform load.

Module III (12 hours)

Equations in polar coordinates - Lame's problem - stress concentration problem of a small hole in a large plate. Axisymmetric problems - thick cylinders - interference fit - rotating discs. **S**pecial problems in bending: Unsymmetrical bending - shear center - curved beams with circular and rectangular cross-section

Module IV (12 hours)

Energy methods in elasticity: Strain energy of deformation - special cases of a body subjected to concentrated loads, due to axial force, shear force, bending moment and torque – reciprocal relation -Maxwell reciprocal theorem - Castigliano's first and second theorems - virtual work principle -minimum potential energy theorem - complementary energy

Module V (12 hours)

Torsion of non-circular bars: Saint Venant's theory - Prandtle's method - solutions for circular and elliptical cross-sections - membrane analogy - torsion of thin walled open and closed sections- shear flow

Text Books

1. L. S. Sreenath, Advanced Mechanics of Solids, McGraw Hill
2. S. M. A. Kazimi, Solid Mechanics, McGraw Hill
3. S. P. Timoshenko, J. N. Goodier, Theory of elasticity, McGraw Hill

Reference Books

1. J. P. Den Hartog, Advance Strength of Materials, McGraw Hill
2. C. K. Wang, Applied Elasticity, McGraw Hill

ME010 504**:** Kinematics of Machinery

(Common with AU010 504)

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

1. *To understand the basic components and layout of linkages in the assembly of a system/machine.*
2. *To understand the principles involved in assembly the displacement, velocity and acceleration at any point in a link of a mechanism.*
3. *To understand the motion resulting from a specified set of linkages.*
4. *To understand and to design few linkage mechanisms and cam mechanisms for specified output motions.*
5. *To understand the basic concepts of toothed gearing and kinematics of gear trains.*

Module I (14hours)

Classification of mechanisms – Basic kinematic concepts and definitions – Degree of freedom, Mobility – Kutzbach criterion, Gruebler's criterion – Grashof's Law –Kinematic inversions of four-bar chain, slider crank chains and double slider crank chains – Limit positions –Mechanical advantage – Transmission Angle -Coupler curves – Description of some common Mechanisms – Quick return mechanisms, Straight line generators, Dwell Mechanisms, Ratchets and Escapements, Universal Joint, steering mechanisms

Module II (12hours)

Displacement, velocity and acceleration analysis of simple mechanisms – Graphical method – Velocity and acceleration polygons – Velocity analysis using instantaneous centers – Kennedy's theorem, kinematic analysis by complex algebra methods – Vector approach – Computer applications in the kinematic analysis of simple mechanisms – Coincident points – Coriolis component of Acceleration.

Module III (10hours)

Kinematic synthesis (Planar Mechanisms) - Tasks of kinematic synthesis – Type, Number and dimensional synthesis – Precision points - Graphical synthesis for four link mechanism Function generator – 2 position and 3 position synthesis – Overlay Method - Analytical synthesis techniques

Module IV (12 hours)

Cams and Followers: - types-follower motion-SHM-uniform velocity and acceleration-Cycloidal - displacement, velocity and acceleration curves-Cam profile-Reciprocating and oscillating followers-Tangent cams-Convex and concave cams with footed followers. Introduction to Polynomial cams.

Module V (12 hours)

Law of toothed gearing – Involutes and cycloidal tooth profiles –Spur Gear terminology and definitions –Gear tooth action – contact ratio – Interference and undercutting – Non-standard

gear teeth – Helical, Bevel, Worm, Rack and Pinion gears [Basics only] Gear trains – Speed ratio, train value – Parallel axis gear trains– Epicyclic Gear Trains – Differentials

Reference Books

1. R L Norton, Kinematics and Dynamics of Machinery, 1st ed., *Tata McGraw Hill Education Private Limited*, Delhi, 2009
2. J. E. Shigley, J. J. Uicker, *Theory of Machines and Mechanisms*, McGraw Hill
3 S .S Rattan Theory of Machines, 3rd ed., *Tata McGraw Hill Education Private Limited*, Delhi, 2009
4 A. Ghosh, A. K. Malik, *Theory of Mechanisms and Machines*, Affiliated East West Press
5 A. G. Erdman, G. N. Sandor, *Mechanism Design: Analysis and synthesis Vol I & II*, Prentice Hall of India

ME010 505 I. C. Engines & Combustion

(Common with AU010 505)

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart the basic concepts of IC Engine and Combustion*

Module I (15 hours)

Working of two stroke and four stroke engines and valve timing diagrams of – Petrol and diesel engine. (Review only). Fuel air cycles. Ignition systems- Battery and magneto systems- ignition timing and spark advance. Fuels – Qualities, rating of fuels - Octane and Cetane numbers. Alternative fuels.

Types of engines - Wankel engine,- Stirling engine - Stratified charge engine - VCR engine - free piston engine.

Module II (15 hours)

Air fuel mixture requirements – Solex Carburettor. Stoichiometric and excess air calculations. Fuel injection systems in SI and CI engines - Fuel injection pumps.- nozzle- direct and indirect injections. MPFI systems and GDI engines. CRDI technology.

Lubrication systems- types – properties of lubricants. Flash point, fire point and viscosity index.

Module III (10 hours)

Thermodynamics of combustion. Combustion reaction of common fuels. Exhaust gas composition. Flue gas analysis. Air fuel ratio from exhaust gas composition. Variation of specific heats- heat losses- Dissociation.

Engine cooling systems- Air and liquid system- Super charging and turbo charging

Module IV (10 hours)

Combustion in SI engines- P-θ diagram- Stages of combustions- Ignition lag. Flame propagation – Abnormal combustion – detonation effects. Combustion in CI engines, P-θ diagram - Ignition delay, diesel knock- controlling methods.

Air motion- Squish, tumble, swirl motions. Different types combustion chamber for SI and CI engines.

Module V (10 hours)

Pollutants in SI and CI engines. NOx, CO, unburned hydrocarbons ,smoke and particulate. Measurement of exhaust emission. (HC, CO, NOx and smoke intensity) Exhaust gas treatment.- Catalytic converter – Thermal reaction -Particulate trap.

Testing of IC engines - Indicated power – Brake Power - Volumetric efficiency - Heat balance test - Morse test.

Text Books

V Ganesan, *Internal Combustion Engine* Tata Mc Graw Hill Publishing Company Ltd. New Delhi 2006. -

Reference Books

John B Heywood, Internal Combustion Engine Fundamentals, Mc Graw Hill Publishing Company Sigapur,1998.

Obert E F,Internal Combustion Engine and air Pollution Mc Graw Hill book company New York.

Mathur and Sharma,A course in Internal Combustion Engine - Dhanpat Rai Publications new Delhi, 2004.

Sharma S.P, Fuels and Combustion, Tata Mc Graw Hill Publishing Company Ltd. New Delhi.1990.

Spalding D.B. Some Fundamentals of Combustion Better Worths Scientific Publications London, 1955.

ME010 506 Thermodynamics

(Common with PE 010 506 and AU010 506)

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart the basic concepts of Thermodynamics*

Pre-requisites: *Knowledge required to study this subject (especially any subject previously studied)*

Module I (10 hours)

Fundamentals concepts – scope and limitations of thermodynamics. Thermodynamic systems – different types of systems – macroscopic and microscopic analysis – continuum – Properties – state – processes. Thermodynamics equilibrium – Equation of state of an ideal gas – PVT system – Real gas relations – Compressibility factor – Law of corresponding states.

Module II (15 hours)

Laws of thermodynamics- Zeroth law of thermodynamics – Thermal equilibrium – Concept of temperature – Temperature scales – Thermometry – Perfect gas temperature scales. – Thermometry – Perfect gas temperature scales. Work and heat – First law of thermodynamics – Concept of energy _ First law for closed and open systems – Specific heats – internal energy and enthalpy – Steady flow energy equations _ Jule Thompson effect.

Module III (15 hours)

Second law of thermodynamics- Various statements and their equivalence_ Reversible process and reversible cycles- Carnot cycles- Corollaries of the second law – thermodynamics temperature scales – Clausis inequality- Concept of entropy – Calculation of change in entropy in various thermodynamic processes – Reversibility and irreversibility – Available and unavailable energy – Third law of thermodynamics.

Module IV (10 hours)

Thermodynamic relations – Combined first and second law equations – Hemholtz and gibbs functions – Maxwell relations- Equations for specific heats, internal energy, enthalpy and entropy – Clausius Clapeyron equations _ applications of thermo dynamic relations.

Module V (10 hours)

Properties of pure substances – PVT, PT and TS diagrams, Mollier diagrams- Mixture of gases and vapours- mixture of ideal gases – Dalton's law – Gibbs law- Thermodynamic properties of mixtures

Text Books

1 P K Nag, *Engineering Thermodynamics*, Tata Mc Graw Hill Publishing Company Ltd. New Delhi 2008.

Reference Books

1. J. F. Lee and FW Sears, *Engineering Thermodynamics,* Addison-Wesleg Publishing Company, London, 1962.
2. Spalding and Cole, *Engineering Thermodynamics,* The English Language Book Society and Edward Arnold Ltd.,1976.
3. M. A.chuthan, *Engineering Thermodynamics*,Prentice Hall of India Private Ltd, New Delhi 2002.
4. J.H Keenan, *Thermodynamics,* John Wiley and Sons , New York, 1963.
5. Edward F Obert, *Concept of Thermodynamics,* McGraw Hill book company New York, 1988.
6. J.P. Holman, *Thermodynamics,* McGraw Hill book company New York, 1988.
7. Mark W. Zemansky, *Heat and Thermodynamic*, McGraw Hill, New Delhi, 2001.
8 Roy T, *Basic Engineering Thermodynamics,* Tata Mc Graw Hill Publishing Company Ltd. New Delhi 1989.

ME010 507**: CAD/CAM Lab**

(Common with PE010 708)

Teaching scheme **Credits:** 2

3 hours practical per week

Objectives

- *To train the students in solid modelling, surface modelling and drafting*
- *To gain experience in assembly modelling, mechanism design and systems routing*
- *To practise computer controlled manufacturing methods*
- *To expose students to rapid prototyping*

Solid Modeling (15 hours)

Creation of 3D models-Wireframe, Surface and Solid modeling techniques using CAD packages- Parametric modeling-Drafting-Generation of orthographic 2D views from models,Sectioning,Detailing –Exposure to Industrial components-Application of Geometrical Dimensioning &Tolerancing.

Assembly Design (15 hours)

Assembling of various machine parts and tolerance analysis, generation of 2D drawings and bill of materials from assembly
Mechanism Design - synthesis and design of mechanisms - animations - exercises on various mechanisms like four bar chain, slider crank mechanism and its inversions
System Design-Schematic and non schematic driven routing of pipes and tubes,

Computer aided manufacturing (15 hours)

Part programming fundamentals - manual part programming and computer aided part programming - hands on training in computer controlled turning and milling operations - tool path generation and simulation - exercises on CNC lathe and machining center/milling machines
Generation of STL files and rapid prototyping of CAD models

Exercises

1) Modeling of machine parts, brackets using 2D drawings
2) Modeling of surfaces using given master geometry
3) Parametric modeling of standard parts such as nuts, bolts, rivets, washers etc
4) Assembling of machine parts
5) Generation of manufacturing drawings from 3D models/assembly
6) Synthesis of four bar mechanism and its simulation using software packages
7) Synthesis of slider crank mechanism and its simulation using software packages
8) Schematic and non schematic routing of pipes/tubes
9) Manual/Computer aided part programming for turning and milling operations
10) Rapid prototyping of simple CAD models

Reference Books

1. CAD and Solid Modeling Software Packages CATIAV5, UNIGRAPHICS and PRO-E Manuals of Latest Version
2. Ibrahim Zeid, R Sivasubrahmanian CAD/CAM: Theory & Practice *Tata McGraw Hill Education Private Limited*, Delhi,
3. Yoram Koren, Computer Control of Manufacturing Systems *Tata McGraw Hill Education Private Limited*, Delhi,
4. Peter Smid, (2003), CNC programming Handbook a comprehensive guide to practical CNC programming, Industrial Press

Internal Continuous Assessment *(Maximum Marks-50)*

50%-Laboratory practical and record
30%- Test/s
20%- Regularity in the class

Note: Exercise in Rapid prototyping may be demonstrated for the entire batch

End Semester Examination *(Maximum Marks-100)*

70% - Procedure, modeling steps, results
30% - Viva voce

ME010 508 Electrical & Electronics Lab

(Common with PE010 508 and AU010 508)

Teaching scheme **Credits:** 2

3 hours practical per week

Objectives

- *To conduct various tests on Electrical Machines and to study their performance.*
- *To conduct various tests on practical electronic circuits*

PART A

1. Study of 3-point and 4-point starters for D.C machines

2. OCC of self excited D.C machines – critical resistances of various speeds. Voltage built-up with a given field circuit resistance. Critical speed for a given field circuit resistance

3. OCC of separately excited D.C machines

4. Load test on shunt generator – deduce external, internal and armature reaction characteristics.

5. Load test on compound generator

6. Swinburne's test on D.C machines

7. Brake test on D.C shunt motors and determination of characteristics.

8. Brake test on D.C series motors and determination of characteristics.

9. Brake test on D.C compound motors and determination of characteristics.

10. O.C and S.C tests on single phase transformers – calculation of performance using equivalent circuit – efficiency, regulation at unity, lagging and leading power factors.

11. Load test on single phase transformers.

12. Alternator regulation by emf and mmf methods

13. Study of starters for three phase induction motors

14. Load tests on three phase squirrel cage induction motors

15. Load tests on three phase slip ring induction motors

16. Load tests on single phase induction motors

PART B

1. Design and testing of clipping and clamping circuits

2. Design and testing of of RC integrator and differentiator circuits.

3. Design and testing of rectifier circuits – Half wave – Full wave (centre – tapped and bridge) circuits. Filter circuits.

4. Design and testing of RC coupled amplifier– frequency response.
Sweep circuits

5. Design and Testing of RC phase-shift Oscillator

References

1. Dr. P S Bimbra, *Electrical Machinery*, Khanna Publishers
2. R K Rajput, *A text book of Electrical Machines*, Laxmi publishers
3. A.P. Malvino, *Electronic Principles*– TMH
4. Floyd, *Electronic Devices*, Pearson Education, LPE

Internal Continuous Assessment *(Maximum Marks-50)*

50%-Laboratory practical and record
30%- Test/s
20%- Regularity in the class

End Semester Examination *(Maximum Marks-100)*

70% - Procedure, conducting experiment, results, tabulation, and inference
30% - Viva voce

ME010 601 Mechanics of Machines

(Common with AU010 601)

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

- To understand the method of static force analysis and dynamic force analysis of mechanisms
- To understand the principles of governors and gyroscopes.
- To understand the design of flywheel
- To understand the working of different types of brakes and dynamometers

Module I (14 hours)

Force analysis of machinery - static and dynamic force analysis of plane motion mechanisms - graphical method - principle of superposition –matrix methods - method of virtual work.

Module II (12 hours)

Governors: - terminology; Watt, Porter, Proel, Hartnell, Hartung, Wilson-Hartnell, and Pickering governors-spring controlled governors of gravity type-effort and power-controlling force diagram-quality of governors-effect of friction-insensitiveness-stability-inertia governors- governor speed, torque characteristics of an engine-governor and flywheel.

Module III (12 hours)

Turning moment diagram and Flywheel: - coefficient of fluctuation of energy and speed- energy saved in a flywheel-punching press-dynamically equivalent two mass system-centre of percussion-kinetic equivalence-reversed effective force analysis-piston effort-crankpin effort- crank effort-turning moment diagrams for I.C. engines.

Module IV (10 hours)

Gyroscope: - Principle-Angular acceleration-Effect of gyroscopic couple on bearings, airplanes, and ships-stability of automobile and two wheel vehicles-Gyroscopic stabilization of sea vessels and grinding mills-Rigid disc at an angle fixed to a rotating shaft

Module V (12 hours)

Brakes and clutches: Shoe, double block, long shoe, internally expanding shoe, band, band & block, hydraulic, mechanical, air and power brakes-braking of a vehicle-cone, single plate, multiple, centrifugal clutches.
Dynamometers: Pony brake. rope brake, epicyclic train, belt transmission and torsion dynamometers-effort and power.

Reference Books

1. R L Norton, Kinematics and Dynamics of Machinery, 1st ed., *Tata McGraw Hill Education Private Limited*, Delhi, 2009
2. J. E. Shigley, J. J. Uicker, *Theory of Machines and Mechanisms*, McGraw Hill
3 S .S Rattan Theory of Machines, 3rd ed., *Tata McGraw Hill Education Private Limited*, Delhi, 2009
4 A. Ghosh, A. K. Malik, *Theory of Mechanisms and Machines*, Affiliated East West Press
5. C. E. Wilson, P. Sadler, *Kinematics and Dynamics of Machinery*, 3rd edition, Pearson Education.
6. Holowenko, Dynamics of Machinery, John Wiley

ME010602: Heat and Mass Transfer

(Common with AU010 602)

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To provide a useful foundation and basic knowledge of the subject required for innovative work and advanced studies.*
- *To motivate the students and to develop interest in the subject by providing information along with practical application of different formulae from an engineering point of view.*

Module I (12 hours)

Scope and application of heat transfer principles in engineering practice. Introduction to basic modes of heat transfer

Conduction: Fourier law-thermal conductivity of solids, liquids and gasses-factors affecting thermal conductivity-common conducting and insulating materials. General heat conduction equation in Cartesian, cylindrical and spherical co-ordinates- one dimensional steady state conduction with and without heat generation-conduction through homogeneous and composite surfaces-plane wall, cylinders and spheres-concept of thermal resistance-contact resistance-variable thermal conductivity-critical thickness of insulation-overall heat transfer coefficient-heat transfer through corners and edges-conduction shape factor.

Module II (12 hours)

Convection: Elementary ideas of hydrodynamic and thermal boundary layers-Newton's law of cooling-factors affecting heat transfer coefficient in forced and natural (free) convection heat transfer-application of dimensional analysis to free and forced convection-significance of Prandtil number, Reynold's number, Grashof number and Nusselt number. Forced convection: Laminar and turbulent flow heat transfer in a circular pipe- Laminar and turbulent flow heat transfer in flow over a flat plate-flow across a cylinder. Natural convection: Natural convection heat transfer from a plate kept vertical and horizontal- cylinder kept vertical and horizontal-description of natural convection heat transfer from enclosed spaces. (Problems limited to using important empirical relations available in data book)

Module III (12 hours)

Heat transfer from extended surfaces: Governing equation and boundary conditions-straight rectangular fin-pin fin of uniform cross sectional area-circumferential fin-fin effectiveness-fin efficiency-solving problems using data book.

Heat exchangers: General classification of heat exchangers according to type of energy transfer, according to flow arrangement and according to area to volume ratio-Log Mean Temperature Difference (LMTD) for parallel flow, counter flow and cross flow arrangements-calculation of heat exchanger size and flow rates from known temperatures. Effectiveness_NTU method of evaluation-solving problems using data book.

Module IV (12 hours)

Radiation: Nature of thermal radiation-definitions and concepts-monochromatic and total emissive power-absorptivity, reflectivity and transmissivity-definition of black, grey and real surfaces-concept of a black body-Plank's law, Kirchoff's law, Wein's displacement law and Stefan-Boltzmann law-geometric factor (shape factor or configuration factor) of simple geometries. Heat exchange by radiation between black surfaces of equal, parallel and opposite black squares and discs-black rectangles perpendicular to each other having a common edge-heat exchange between infinite parallel planes of different emissivity-radiation shield (no derivation)-simple derivations and simple problems using data book.

Module V (12 hours)

Mass Transfer: Introduction to mass transfer-Fick's law of diffusion-steady state mass diffusion of gasses and liquids through solids-convective mass transfer (elementary concepts and definitions)-analogy between heat and mass transfer-elementary problems.

Condensation and boiling: Laminar film condensation on a vertical plate and horizontal tubes. Pool boiling-different regimes of pool boiling-flow patterns in flow boiling in a vertical tube.

Two dimensional steady state heat conduction-governing equation and boundary conditions-application of finite difference method in solving two dimensional steady state heat conduction through a rectangular slab (method of discretisation of nodal equations only)

Data Book:

1. C. P. Kothandaraman, S. Subramanyan, *Heat and Mass Transfer Data Book*, 5th ed., New Age International Publishers.
2. A. V. Domkundwar, Dr. V. M. Domkundwar, *Heat and Mass Transfer Data Book*, 3rd ed., Danapat Rai & Co.

References:

Text Books

1. S. P. Sukhatme, *A Text Book on Heat Transfer*, 4th ed.,Universities Press, Hydrabad, 2005
2. S. K. Som, *Introduction to Heat Transfer*, PHI Learning pvt.ltd,New Delhi, 2008
3. P. K. Nag, *Heat Transfer*, 1st ed., Tata McGraw-Hill

Reference Books

1. Frank P. Incropera, David P. Dewitt, *Fundementals of Heat and Mass Transfer*, 5th ed., John Wiley & Sons
2. J. P. Holman, *Heat Transfer*, 9th ed., Tata McGraw Hill Education pvt.ltd., New Delhi, 2010
3. M. Necati Ozisick, *Heat Transfer A Basic Approach*, McGraw Hill Book Company
4. Frank Kreith, Mark S. Bohn, *Principles of Heat Transfer*, 5th ed , PWS Publishing Company
5. S. P. Venkateshan, *A First Course in Heat Transfer*, Ane Books, Chennai

ME010 603 Thermal Systems and Applications

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart the basic concepts of different types of engines*
- *To develop an idea about various thermal systems..*

Module I (12 hours) Steam Engineering: Properties of steam - wet, dry and superheated steam - dryness fraction - enthalpy and internal energy - entropy of steam - temperature entropy diagram - process - Mollier chart - Rankine cycle for wet, dry and superheated steam. Steam Generators - classification - modern steam generators - boiler mountings and accessories.

Module II (12 hours) Steam nozzles - Mass flow rate - throat pressure for maximum discharge - throat area - effect of friction - super saturated flow.
Steam turbines: velocity triangles, work done, governing, and efficiencies.

Module III (12 hours) Gas turbine Plants - Open and closed cycles - thermodynamics cycles - regeneration, re heating - inter cooling - efficiency and performance of gas turbines. Rotary Compressors - Analysis of rotary compressors - centrifugal and axial compressors and reciprocating compressors. Combustion - combustion chambers of gas turbines - cylindrical, annular and industrial type combustion chamber - combustion intensity - combustion chambers efficiency - pressure loss combustion process and stability loop.

Module IV (12 hours) Introduction to solar energy - solar collectors - Liquid flat plate collectors - principle - thermal losses and efficiency - characteristics - overall loss coefficient - thermal analysis - useful heat gained by fluid - mean plate temperature - performance - focussing type solar collectors - solar concentrators and receivers - sun tracking system - characteristics - optical losses - thermal performance - solar pond - solar water heating - solar thermal power generation (Description Only)

Module V (12 hours) Thermal power plants: layout and operation of steam and diesel power plants - coal burners - stockers - cooling ponds & towers - chimneys - draught - dust collectors - precipitators - feed water heaters - evaporators - steam condensers - coal handling - ash handling.

Text Books

1. E. L. Wahid , *Power plant technology*
2. Mathur and Mehta, *Thermodynamic and heat power engineering*, Jain Brothers.
3. P. L. Ballaney , *Thermal Engineering*, Khanna publishers

Reference Books

1. Cohen & Rogers, *Gas Turbine Theory*
2. G. D. Rai, *Solar Energy Utilization*
3. R.K. Rajput, *Thermal engineering*, Lakshmi publications

ME010 604: Metrology and Machine Tools

(Common with AU010 604)

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *Understand and appreciate the importance of basic principles of traditional material removal processes.*
- *Understand the application of those principles in practice.*
- *To understand the principles of metrology and measurements, methods of measurement and its application in manufacturing industries.*

Module I (12 hours)

Conventional Machining Processes Turning machines:- Types - method of holding work and tool, accessories, attachments-operations and types of tools for each operation - tool room lathe - duplicating lathe - Capstan and Turret lathe – knurling - Drilling:- types of drilling machines - types of drills - nomenclature of drill point - drill wear - types of chip breakers - cutting forces in drilling - Boring:- types of boring machines, tool geometry - counterboring, spot facing, countersinking, trepanning – Reaming:- types of reamers - tool nomenclature - cutting forces - tool materials and surface roughness obtainable in each operations.
Shaping, planing and slotting machines**:-** Types and specifications - quick return motion - hydraulic feed and its advantages - automatic feed-speed, feed and depth of cut -work holding devices - types of operation and examples of work done - shaping of V-blocks, planing of guide gibs, slotting of keyways – Broaching:- - basic process - different cutting elements – force required for broaching and strength of broach – tool materials and surface roughness obtainable in each operations.

Module II (12 hours)

Milling operations:- different types milling machines **-** Different methods of milling - nomenclature of milling cutters – cutting forces in milling – different types of milling cutters – attachments for milling:-vertical milling and universal milling attachment, high speed milling attachment, rack milling and slot attachments, parking bracket, rotary table, universal dividing head, vices, arbors, adaptors and collet chucks – tool materials and surface roughness obtainable in milling – machining centers: applications and advantages - Grinding**:** - types of machines - Grinding mechanisms:- grinding debris, grinding force power, specific energy - Grinding wheels:- different types of abrasives, grain size, different types of bond, grade, structure – marking system of grinding wheels - Grinding fluids – Truing and dressing of grinding wheels - Grinding temperature, thermal damage and surface roughness obtainable.
Horning**:** Types of machines, methods of honing – types honing stones – honing conditions - cutting fluids - surface roughness obtainable - Lapping**: -** types of hand lapping - types of lapping machines - surface roughness obtainable – Burnishing**:-** processes and surface roughness obtainable.

Module III (12 hours)

Gear cutting process**: -** Gear milling: - gear milling machines and different gear milling operations - Gear hobbing: - principle of the hobbing process and hobbing machines, basic types of hobbing machines, different hobbing techniques, nomenclature of hob, hob wear, spur gear hobbing, helical gear hobbing - gear shaping**: -** principle of gear shaping process - gear finishing - gear errors - Thread production process: - different thread production processes: screw cutting on lathe, thread milling, thread whirling, die threading, tapping, thread rolling, and thread grinding.

Module IV (12 hours)
Engineering Metrology

General measurements concepts:- Principles for achieving accuracy; methods for estimating accuracy and precision, precision Vs accuracy, systematic and constant errors; progressive, random, erratic, drunken errors - Fits and tolerances:- types of fits: hole and shaft basis system – limit gauges:- gauge tolerance, presentation of gauge tolerances – Taylor'**s** theory of gauging – limit gauges for screw threads - Design and operation of linear measurements:- Principle of alignment (Abbe's**)**, accuracy and precision etc. – Principle of kinematics: complete constraints, one degree of freedom – Gauge blocks:- gauge materials, accuracy and standards, effect of temperature, surface roughness and manufacturing of gauge blocks – Comparators:- mechanical, mechanical-optical, pneumatic and horizontal length comparator – Angle measurements:- three disc, sine bar and dial gauge – measurement of taper plug ring gauges and taper bores – Precision levels, clinometer – Optical instruments for angle measurements:- optical principles of projector, microscope, telescope, collimator, auto collimator - optical flat and optical parallel applications – auto collimator, angle dekkor, combination of angle gauges, optical flat.

Module V (12 hours)

Tool makers microscope – profile projector – optical microscope, SEM and TEM - straight edge – surface plate – measurement of squareness:- squareness testing with dial gauge, tilting bar, optical square, checking an internal right angle - Measurement of surface roughness: meaning of surface texture and causes – stylus probe instrument, RMS, CLA, peak to valley, R_a, R_t, R_z etc. – stylus, skid, effect of sampling length, magnification, cut-off, evaluation length etc. – comparison of surface roughness of different machining process – concept of apparent to real area of contact of mating surfaces, applications in clutch plate surface, brake liner, inner race of a bearing, cylinder liner, machine tool guide way, significance of surface roughness in crack initiation – assessment of roundness errors:- least square reference circle, minimum circumscribed circle, minimum zone reference circle and maximum inscribed circle – roundness parameters:- eccentricity, concentricity and runout – three wire system of thread pitch diameter measurement - gear tooth measurement by vernier caliper, pin method of measuring gear teeth – Alignment tests for machine tools:- test for level installation of a lathe bed – spindle tests of concentricity and alignment with guide ways – tests for straightness and flatness of a lathe bed guide ways – test for squreness of a drilling machine spindle with table – CMM, laser interferomerty and applications.

Text Books

1. S. Haykin and B. V. Veen, *Signals and Systems*, John Wiley & Sons, N. Y., 2002
2. A. V. Oppenheim, A. S. Willsky and S. H. Nawab, *Signals & Systems*, 2nd ed., Prentice Hall of India, New Delhi, 1997

Reference Books

1. C. L. Philips, J. M. Parr, E. A Riskin, *Signals, Systems and Transforms*, 3rd ed., Pearson Education, Delhi, 2002
2. R. E. Zeimer, W. H. Tranter, and D. R. Fannin, *Signals and Systems: Continuous and Discrete*, 4th ed., Pearson Education, Delhi, 1998
3. M. J. Roberts, *Signals and Systems: Analysis using Transform methods and MATLAB*, Tata McGraw Hill, New Delhi, 2003

ME010 605 Mechatronics and Control systems

(Common with AU010 605)

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart basic concepts of mechatronics and control systems.*

Module 1 [12 Hours]

Introduction:-Scope of Mechatronics-Systems-Microprocessor based controllers-mechatronic approach-sensors-transducers-force-velocity-displacement-temperature-inputting data by switches-signal conditioning-operational amplifiers-filtering-multiplexers-data acquisition-modulation. Data presentation systems:- Displays-measurement systems-calibration-pneumatic and hydraulic systems-control valves-actuators-mechanical and electrical activation systems-relays and solenoid switches-proximity pickups.

Module 2 [12 Hours]

Input/output Systems:-Ports, interface requirements, adaptors-programmable logic controllers-data handling digital communications-system, networks, protocols, interfaces, fault finding- design and mechatronic design solutions. Electromechanical systems:-CD, DVD Rom, OCR, Printers.

Module 3 [12 Hours]

Introduction to Control Systems Engineering:-Concept of automatic control-open loop and closed loop systems-servomechanisms-Block diagrams-transfer functions-Representation of control components and systems-Translational and rotational mechanical components –series and parallel combinations-comparators ,integrating devices, hydraulic servomotors, temperature control systems, speed control systems.

Module 4 [12 Hours]

System Response:-First and second order system-Response to step, pulse, ramp and sinusoidal input-systems with distance, velocity lag. Control System Analysis:-Transient Response of simple control systems –Stability of control systems –Routh Stability criteria –Error Analysis.

Module 5 [12 Hours]

Frequency Response Analysis :- Polar ,Rectangular and Logarithmic plots – Experimental determination of frequency response -Bode and Nyquist stability criteria – Gain and phase margin. Root locus of simple transfer function.

Text Books

1. Mechatronics-W.Bolton-Pearson
2. Control Systems- A. Nagoor Kani

References

1. Mechatronics-A.Smaili&F.Mrad-Oxford
2. Control Systems Engg –T .J. Nagrath & M .Gopal.
3. Automatic Control Theory-Ravan.
4. Modern Control Engg.-K. Ogatta
5. Control Systems Engg -Benjamin C Kuo

ME010 606L01 Computational Fluid Dynamics

Teaching scheme **Credits:** 4
2 hours lecture and 2 hour tutorial per week

Objectives

- *To introduce the primary components of learning and practicing CFD*
- *To develop an understanding of solution methods for fluid motion and energy transfer equations*

Module 1 (15 hours)
Basic concepts: conservation principles – derivation of transport equations: control volume – Langangian and Eulerian approach- mass conservation equation-momentum conservation equations-stress laws-mass transfer equation-energy equation-rate change-convection and conduction-volumetric generation-work done by surface and body forces- dimensionless form of Navier-Stokes equations- introduction to numerical methods, advantages and limitations.
Module 2 (10 hours)
One dimenensional conduction: The governing equation- grid layout-discretisation-stability and convergence-explicit, implicit and semi-implicit procedures-methods to handle non-linearities- Solution methods-Gauss-Siedel method and TDMA-Simple problems.
Module 3 (10 hours)
One dimensional conduction-convection: exact solution-discretisation- central difference scheme-upwind difference schemes- numerical false diffusion-stability of unsteady equation-exact solution-explicit finite difference form-implicit finite difference form.
Module 4 (10 hours)
Two dimensional boundary layers: governing equations- descretisation method- symmetry, wall and free stream boundary conditions- dealing with source terms –defining initial conditions-choice of grid size and iterations-applications (excluding turbulence)
Module 5 (15 hours)
Two dimensional Convection-Cartesian Grids: simple mathematical models for incompressible, in viscid, potential and creeping flows-approximations of hyperbolic, parabolic, elliptic, and mixed flows. Solution strategies for 2D convection problems- SIMPLE algorithm-descretisation- pressure correction equation- solution procedure- Solution methods: iterative solvers-evaluation of residuals-under relaxation-boundary conditions - simple description on treatment of turbulent flows - applications (laminar flows only).

Text Books

1. Anderson J.D., *Computational Fluid Dynamics,* McGraw- Hill Co.
2. Joel H. Ferzigerand Peric M., *Computational methods for Fluid Dynamics,* Springer Werlag Publishers

Reference Books

1. Patankar S.V., *Numerical Fluid Flow and Heat Transfer* , Hemisphere, New York
2. Anil W. Date, *Introduction to Computational Fluid Dynamics,* Cambridge University Press
3. Hiderbrand F.B., *Introduction to Numerical Analysis* , Tata McGraw- Hill

ME010 606 L02: Composite Materials Technology

Teaching scheme **Credits:** 4
2 hours lecture and 2 hour tutorial per week

Objectives: To understand the concept of composite materials

Module I (12 hours)

Fibers**:** introduction – glass fibers: fabrication, structure, properties and applications – Boron fibers: fabrication, structure, morphology, properties and application – Carbon fibers: Different preparation methods, structural change during preparation, properties and application – Aramid fibers: fabrication, structure, properties and applications – Ceramic fibers: Alumina and silicon carbide fibers – metallic fibers.

Module II (12 hours)

Matrix materials: Polymers and its characteristics – Metals: fiber reinforcement of metals - Ceramic matrix materials: bonding and structure, effect of flaws on strength and common ceramic matrix materials.

Interfaces**:** wettability and bonding interface in composites – types of bonding at interface – tests for interfacial strength.

Module III (12 hours)
Metal Matrix Composites (MMC)**:-** Different fabrication methods of MMC – interface in MMC – discontinues reinforcement of MMC – detailed discussion on mechanical properties – applications.

Module IV (12 hours)
Ceramic Matrix Composites (CMC)**:-** Different fabrication methods of CMC – interface in CMC – detailed discussion on properties – toughness of CMC - applications.
Carbon fiber composites: fabrication – properties – interface.

Module V (12 hours)

Micromechanics of composites: Maximum stress and strain criterion, Tsai-Hill and Tsai-Wu failure criterion (derivations) - mechanics of load transfer from matrix to fiber (description only).
Polymer matrix composites**:** properties and engineering applications **–** processing of PMC: hand lay-up, spray up, compression molding, reinforced reaction injection molding, resin transfer molding, pultrusion, filament winding, injection, vacuum bag molding process.

Text Books

1. S. Haykin and B. V. Veen, *Signals and Systems*, John Wiley & Sons, N. Y., 2002
2. A. V. Oppenheim, A. S. Willsky and S. H. Nawab, *Signals & Systems*, 2nd ed., Prentice Hall of India, New Delhi, 1997

Reference Books

1. C. L. Philips, J. M. Parr, E. A Riskin, *Signals, Systems and Transforms*, 3rd ed., Pearson Education, Delhi, 2002
2. R. E. Zeimer, W. H. Tranter, and D. R. Fannin, *Signals and Systems: Continuous and Discrete*, 4th ed., Pearson Education, Delhi, 1998
3. M. J. Roberts, *Signals and Systems: Analysis using Transform methods and MATLAB*, Tata McGraw Hill, New Delhi, 2003

ME010 606L03: AUTOMOBILE ENGINEERING

Teaching scheme **Credits:** 4
2 hours lecture and 2 hour tutorial per week

Objectives

- *To impart the basic concepts of Automobile parts and its working*
- *To develop an idea about the fundamentals on modern vehicle technologies.*

Module 1 (12 hours)

Engines: Types of engines in automobiles-classifications-engine components-working of various systems-present and future vehicles, engine construction- intake and exhaust systems. Different combustion chambers, carburetors, diesel fuel pumps, injectors, single point and multi point fuel injection-MPFI and CRDI systems - lubricating and cooling systems.

Vehicle performance-resistance to the motion of vehicle-air, rolling, and radiant resistance-power requirement-acceleration and gradeability-selection of gear ratios.

Module 2 (12 hours)

Transmission: prime movers- clutch-principle of friction and cone clutches – centrifugal clutches, diaphragm clutches and fluid couplings-Gear box-necessity and principle. Constant mesh, sliding mesh, synchromesh gear boxes and epicyclic gearbox –overdrives. Hydraulic torque converters-semi and automatic transmission systems - constant velocity and universal joints. Final drive-front wheel, rear wheel and four wheel drives-transfer case-Hotchkiss and torque tube drives-differential-non-slip differential-rear axles-types of rear axles.

Module 3 (12 hours)

Steering and Suspension: Different steering mechanisms- Ackermann Steering mechanism. Steering gear boxes- power steering –types. Suspension systems-front axle, rigid axle and independent suspensions-anti-roll bar-coil spring and leaf spring - torsion bar -Macpherson strut- sliding pillar- wish bone- trailing arm suspensions-Shock absorbers -hydraulic and gas charged shock absorbers-air suspensions

Front axle types-front wheel geometry-castor, camber, king pin inclination, toe-in toe-out , wheel balancing- wheel alignment.

.

Module 4 (12 hours)

Chassis, Brakes and Tyres: Types of chassis and body constructions-crumble zones, air bags and impact beams. Braking mechanism and convectional brakes- Drum brakes and Disc brakes. Vacuum booster, hydraulic and power brakes, components and attachments of mechanical, hydraulic and pneumatic brakes-Master cylinder-Tandem cylinder- working. Anti-lock braking systems-Wheels and Tyres- tubeless tyres-ply ratings- radial tyres. Different tyre wears- causes

Module 5 (12 hours)

Electrical systems - Battery ignition system circuit- electronic ignition system alternators - voltage regulators starting system- bendix and follow through drives – automotive lighting, accessories and dashboard instruments- head light and horn with

relays-circuit diagrams. Automotive air conditioning Preventive and breakdown maintenance- engine testing, servicing-engine overhaul- engine tuning.

Text Books

1. Kripal Singh , *Automobile Engineering (Vol. 1 & 2)*
2. V.A.W Hillier & Peter Coombes, *Hillier's Fundamentals of Motor Vehicle Technology*. New Age International.

Reference Books

1. K.M.Guptha , *Automobile Engineering (Vol. 1 & 2)*
2. Joseph Heitner, *Automotive Mechanics*
3. Harbans Singh Reyd, *Automobile Engineering*
4. William H. Course, *Automotive Mechanics*

ME010 606L04:Advanced Strength of Materials

(Common with PE 010 606L05)

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Objectives

- *To analyse the stresses and deformations through advanced mathematical models.*
- *To estimate the design strength of various industrial equipments.*

Module 1 (12 -hours)

ANALYSIS OF PLATES Mathematical modeling of plates with normal loads – Point and Distributed Loads – Support conditions – Rectangular plates - Stresses along coordinate axes – Plate deformations – Axi-symmetric plates – Radial and tangential stresses – plate deflections.

.

Module II (14-hours)

THICK CYLINDERS AND SPHERES Equilibrium and compatibility conditions - Lame's Theorem – Boundary conditions – distribution of radial and tangential stresses – compound cylinders – Interference fits - Stresses due to temperature distributions. piston, oscillating motor-characteristics.

Module III (12 -hours)

ROTATING DISCS Lame-Clayperon Theorem – radial and tangential stresses in discs due to centrifugal effects – boundary conditions – solid and hollow discs – Interference fit on shafts –Strengthening of the hub – residual stresses – Autofrettege – Discs of variable thickness – Disc profile for uniform strength.

Module IV (12 - hours)

BEAMS ON ELASTIC FOUNDATION Infinite beam subjected to concentrated load – Boundary Conditions – Infinite beam subjected to a distributed load segment – Triangular load – Semi infinite beam subjected to loads at the ends and concentrated load near the ends – Short beams.

Module V (10 - hours)

CURVED BEAMS AND CONTACT STRESSES Analysis of stresses in beams with large curvature – Stress distribution in curved beams – Stresses in crane hooks and C clamps – Contact Stresses – Hertz equation for contact stresses – applications to rolling contact elements.

Text Books

1. Boresi A.P., Schmidt R.J., "Advanced Mechanics of Materials", John Wiley and Sons, Sixth edition, 2003.
2. Dally J.W. and Riley W.F, "Experimental Stress Analysis", John Wiley and Sons 2003

Reference Books

1. Burr A. H., CheathAm J.B., "Mechanical Analysis and Design", Prentice Hall of India, Second edition, 2001.
2. Den-Hartog J.P., "Strength of Materials", John Wiley and Sons..

ME010 606L05: Industrial Hydraulics

(Common with PE 010 606L05)

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Objectives

- *To impart the basic concepts of Fluid properties, hydraulic machines and pumping machinery*
- *To develop an idea about pressure measurements working and properties of hydraulic machines and various types of pumping machineries.*

Module 1 (14 -hours) Introduction to hydraulic / pneumatic devices. Symbols and nomenclature. Power transmission, Hydraulic pumps-classifications, characteristic **C**omparison of electric, hydraulic and pneumatic devices. Hydraulic accumulators.

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Module II (14-hours) Pumps and motors: Principle of working. Hand pumps-single acting, double acting, multi- displacement. Gear pumps- internal, external and gear ring. Screw, vane, piston pumps – axial piston pump, swash pump, bent axis pump radial and series pumps. Types of hydraulic motors, gear motors, vane motors, piston motors- radial piston, rolling vane, ball piston, oscillating motor-characteristics. Telescopic cylinder, cylinder cushion**.**

Module III (12 -hours) Hydraulic valves: Directional control valve, shuttle valve, pressure control valve Stop valve- non return valve-relief valve-sequence valve-counter balance valve- pressure reducing valve – flow control valve –direction control valves- throttling, non throttling- open centre and closed centre and tandem centre valves- their principle of operation.

Module IV (12 - hours) Hydraulic Circuits and Circuit fundamentals. Flow divider and combiner. Piping terminology, control terminology, flow control of hydraulic pump, velocity control- characteristics. Different types of switching and its merits Meter in and meter out. Applications of unloading valve. Application of pressure reducing and pressure sequence valve.

Module V (8 - hours) Properties of commonly used hydraulic fluids-Typical hydraulic circuits used in machine tools –Rivetter- pneumatic Hammer, hydraulic press, and power steering

Text Books

1. S.R.Majumdar, *Oil Hydraulics and Systems-Principles and maintenance*, TMH
2. John Pippenger & Tyler Hicks - *Industrial Hydraulics*

Reference Books

1. Daniel Bonteille -*Fluid Logic and Industrial automation*.
2. Pneumatic Systems –*Principles and Maintanance by S.R Majumdar*, TMH
3. Esposito- *Fluid power with applications*.

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ME010606 L06 Project Management

Teaching scheme **Credits:** 4
2 hours lecture and 2 hour tutorial per week

Objectives

- *To impart the basic concepts of Project selection.*
- *To develop an understanding of tools, techniques and software available for Project Management.*

Module 1 (10 hours)
Introduction, Capital Investments, Phases of Capital Budgeting, Project Characteristics, Taxonomy of Projects, Project Identification and Formulation. 7-S of Project Management. Project feasibility Analysis- Market and Demand Analysis, Technical Analysis, Financial Analysis, Ecological Analysis, Social Cost Benefit Analysis.

Module 2 (15 hours)
Cost of the Project, Means of Finance, Financial Evaluation of projects- Pay back period method, Accounting Rate of Return method, Net Present Value method, Internal Rate of Return method, Benefit Cost Ratio method, etc., Simple Problems.

Module 3 (10 hours)
Risk Analysis-risk in economic analysis-measuring risk in investment; Sources, Measures and Perspectives on Risk, Techniques used for risk analysis – Decision trees, Simulation, Break-even Analysis etc., Techniques for Managing Risk.

Module 4 (15 hours)
Project Scheduling- PERT and CPM techniques, Estimates -time, cost, resources (man, material, tool), Crashing of Projects, Project scheduling with constrained resources, resource leveling, resource Allocation.

Module 5 (10hours)
Computer Aided Project management, Essential Requirement of Project Management Software, MS Project 2010 software, Features and Facilities in Project 2010, Types of Reports available in Project 2010 etc. Project Management Information Systems (PMIS), PMIS sotware, Web- Enabled Project Management.

Text Books

1. Prasanna Chandra, *Projects*, Tata McGraw Hill.
2. Nagarajan K, *Project Management 4th edition*, New Age International (P) Ltd.

Reference Books

1. Nicholas J. M. & Steyn H., *Project Management*, Elsevier.
2. Brian Kennemer and Sonia Atchison, *Using Microsoft Project 2010*, Que Publishing.
3. Harvey Maylor, *Project Management*, Pearson Education.
4. Panneerselvam & Senthilkumar, *Project Management*, PHI

ME010 607: HEAT ENGINES LABORATORY

(Common with AU010 607 and AN010 607)

Teaching scheme **Credits:** 2
3 hours practical per week

Objectives

- *To provide experience on testing of IC engines performance.*

Study of systems and components of IC Engines and automobiles - study of dynamometers used in engine testing - study of IC Engine repairs and maintenance.

Study of boilers, boiler mountings and accessories - study of steam engine parts and systems.

Testing of IC engines • Performance analysis of IC engine using computerized test rig-
Load test on petrol and diesel engines- determination of indicated and brake thermal efficiencies - mechanical efficiency - relative efficiency - volumetric efficiency - air-fuel ratio and compression ratio - valve timing diagram - retardation test - Morse test - heat balance - effect of varying the rate of cooling water and varying the speed on the performance characteristics of engines.

Testing of steam boiler - boiler trial - steam calorimeters and steam nozzles - performance test on steam engines - performance test on steam turbines.

Testing of fuels and lubricants - determination of flash and fire points of petroleum products - determination of kinematics and absolute viscosity of lubricating oils - determination of calorific values

Internal Continuous Assessment *(Maximum Marks-50)*

50%-Laboratory practical and record
30%- Test/s
20%- Regularity in the class

End Semester Examination *(Maximum Marks-100)*

70% - Procedure, conducting experiment, results, tabulation, and inference
30% - Viva voce

ME010 608 Machine Tool Laboratory

(Common with AU010 608)

Teaching scheme **Credits:** 2

3 hours practical per week

List of Experiments

1. Study of precision tools used in machine tool laboratory: – Vernier caliper, micrometers, surface plates, surface gauges, gauge block, straight edges, dial gauge, plug and ring gauges, slip gauges, sine bar, care of tools and gauges. – **2 practices**.
2. Study of lathe tools and accessories: - Selection of tool for different operations - tool materials: high carbon steel, HSS, cemented carbides, coated WC, indexable inserts, alumina, cBN, diamond etc. - tool nomenclature and attributes of each tool angles on cutting processes – effect of nose radius, side cutting edge angle, end cutting edge angle and feed on surface roughness – tool grinding and safe working practices. - 1 **practice.**
3. Selection of speeds, feeds and depth of cut – selection of cutting fluids – different methods of holding work. **- 1 practice.**
4. Experiment on arc and gas welding: - butt welding and lap welding of M.S. sheets. **- 1 practice.**
5. (a) Measurement of cutting forces in turning process using dynamometers.
   (b) Experiment on lathe:- Facing, plain turning, step turning and parting - groove cutting, knurling and chamfering - form turning and taper turning - eccentric turning.
   (c) Measurement of flank wear in turning process using tool makers microscope.
   - 3 practices.
6. Experiment on thread cutting: - single and multistart external and internal threads, square and V-threads. **- 1 practice.**
7. Disassembly and assembly of small assemblies such as tail stock, bench vice, screw jack etc. **- 1 practice.**
8. Experiment on drilling machine: - drilling, boring, reaming and counter sinking – taping – study of reamers and taping. **- 1 practice**.
9. Study and demonstration of N.C. machines:- CNC machines components - Point to point, straight cut and contouring positioning - incremental and absolute systems – open loop and closed loop systems – DDA integrator and interpolators - part programming fundamentals - manual programming – tape format – sequence number, preparatory functions, dimension words, speed word, feed world, tool world, miscellaneous functions – Computer aided part programming:- APT language structure: geometry commands, motion commands, postprocessor commands, compilation control commands – programming, simulation and demonstration exercises involving plane taper and form turning etc.
   - 3 practices.

Besides to the skill development in performing the work, prepare the control charts and oral examination should also be carried out. Observation and record books are to be maintained.

The student's assessment, continuous evaluation, awarding of sessional marks, record bonafides, oral examination etc and University examination shall be carried out by the faculty members (lecturer and above).

TEXT BOOKS:

1. Acharkan. N., Machine Tool Design Vol. 1 to 4, MIR Publication.

REFERENCE BOOKS:

1. Chapman, Workshop Technology, Vol II, ELBS.
2. HMT, Production Technology, Tata McGraw Hill.
3. Yoram Koren, Numerical Control of Machine Tools, McGraw-Hill.

ME 010 701 Design of Machine Elements

(Common with AU010 701)

Teaching scheme **Credits:** 4

2 hours lecture, 1 hour tutorial and 1 hour drawing per week

Objectives

To provide basic knowledge on the design considerations and methodology of various machine elements.

Module I (15 Hrs)

System design cycle - Different phases in design process - design factors and considerations - tolerances and fits - Hole basis & Shaft basis system - standardization - selection of materials - stress concentration - Methods to reduce stress concentration - theoretical stress concentration factor - theories of failure - Guest's theory - Rankine's theory - St. Venant's theory - Haigh's theory - Von Mises & Hencky theory - shock and impact loads - fatigue loading - endurance limit stress- Factors affecting endurance limit - Factor of safety - creep and thermal stresses.

Module II (15 Hrs)

Design of riveted joints- Failure of riveted joints and efficiency of joint -boiler and tank joints- structural joints, Cotter and Knuckle joints

Threaded joints - thread standards- thread nomenclature - stresses in screw threads- bolted joints preloading of bolts- eccentric loading- fatigue loading of bolts - Power screws.

Module III (15 Hrs)

Design of welded joints- Representation of welds - stresses in fillet and butt welds- design for static loads - bending and torsion in welded joints- eccentrically loaded welds - design of welds for variable loads.

Springs- stresses and deflection of helical springs with axial loading - curvature effect - resilience - design of spring for static and fatigue loading- surging- critical frequency- stress analysis and design of leaf springs..

Module IV (15 Hrs)

Shafts and axles design- stresses- causes of failure in shafts - design based on strength, rigidity and critical speed- design for static and fatigue loads- repeated loading- reversed bending-

Design of couplings - Rigid and flexible couplings - design of keys and pins.

Note: Any one of the following data book is only permitted for reference in the University examination

1. Machine Design Data hand book by K. Lingaiah, Suma Publishers, Bangalore/ Tata Mc Graw Hill
2. PSG Design Data, DPV Printers, Coimbatore.

Text Books

1. C.S, Sarma, Kamlesh Purohit, Design of Machine Elements, Prentice Hall of India Ltd , New Delhi
2. M. F. Spotts, T. E. Shoup, Design of Machine Elements, Pearson Education.
3. V.B. Bhandari, Design of Machine Elements, McGraw Hill Book Company

Reference Books

1. J. E. Shigley, Mechanical Engineering Design, McGraw Hill Book Company

ME 010 702: Dynamics of Machines

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Objectives

- *To understand the basic principles involved in the balancing of rotating and reciprocating masses*
- *To understand the basic concepts of vibration of single degree of freedom systems*
- *To understand the methods of analysis of two degree and multi degree of freedom systems.*
- *To understand the concepts in transient and non linear vibration*
- *To understand the methods of noise control*

Module I (14 hours)

Balancing: - Balancing of rotating masses, static balancing and dynamic balancing, Balancing of several masses rotates in same plane, balancing of several masses rotating in several planes, Balancing machines.
Balancing of reciprocating masses: - The effect of inertia force of the reciprocating mass on the engine. Partial primary balance. Balancing of multi cylinder inline engines, v-engines, Radial engines, Direct and Reverse cranks

Module II (16 hours)
Vibrations: - Definitions, simple harmonic motion. Single degree freedom systems: -
Undamped free vibrations: - Equations of motion Natural frequency, Energy method, Equilibrium methods, Rayleigh's methods, Equivalent stiffness of spring combinations.
Damped free vibrations: - Viscous damping, Free vibrations with viscous damping, Over damped system, Critically damped system, Under-damped system, Logarithmic decrement, viscous dampers, Energy dissipated by damping,
Forced Vibrations: - Forced harmonic excitation, Base Excitation, Vibration isolation and Transmissibility. Vibration measuring instruments.

Module III (14 hours)
Two degree freedom systems: - Principal modes of vibration, Rectilinear and angular modes, systems with damping, vibration absorbers, Centrifugal pendulum damper, Dry friction damper, untuned viscous damper.
Multi-degree of freedom system: - Free vibrations, equations of motion, Influence
Coefficients method, lumped mass systems, distributed mass systems (basics only), Stodola method, Dunkerly's method.
Torsional Vibrations: - Torsionally equivalent shaft, torsional vibration of two rotor, three-rotor, and geared systems

Module IV (14 hours)

Critical speeds of shafts: - Critical speed of a light shaft is having a single disc without damping.

Transient vibration: - Laplace transformation, response to an impulsive input, response to a step input, phase plane method, shock spectrum.

Non-linear vibrations: - Phase plane, undamped free vibration with non-linear spring forces, hard spring, soft spring, Forced vibration with nonlinear forces, Duffings equation, self excited vibrations - problems.

Module V (12 hours)

Acoustics: - Sound propagation, decibels, acceptance noise levels, Air columns, acoustical measurements, Doppler Effect, microphones and loud Speakers. Recording and reproduction of sound, Fourier's theorem and musical scale, Acoustic impedence filters.

Environmental noise control: Industrial noise control strategies Noise ratings, human ear. human tolerance levels, equivalent sound level and loudness contours - Noise control through barriers and enclosures and absorbent linings - problems.

References

1. Theory of Machines - Thomas Bevan
2. Theory of Machines - P.L. Ballaney
3. Mechanical Vibrations, V edition - G.K. Groover
4. Theory of Vibrations with applications, III Edn - W.T. Thomson
5. Mechanical Vibrations - S. Graham Kelly, Schaum's outlines
6. Fundamentals of Vibrations - Leonard Meirovitch, Mac Graw Hill
7. A text book of sound - L.P. Sharma & H.C. Saxena
8. Engineering Noise Control - D.A. Bies & C.H. Hausen.
9. Noise & Vibration Control - Leo N. Beraneck

ME 010 703: Gas Dynamics and Jet Propulsion

Teaching scheme **Credits:** 3

2 hours lecture and 1 hour tutorial per week

Objectives

- *To impart the basic concepts of dynamics and thermodynamics of gas flow.*

Module I (7 hours)

Introduction: Continuum- Control Volume and System approaches- Continuity and Momentum equations for control volume- Mach number- Velocity of sound- Classification of flow based on Mach number- Physical difference between incompressible, subsonic and supersonic flow- Mach angle- Karman's rule of supersonic flow- Effect of Mach number on compressibility- General features of one dimensional flow of compressible fluid.

Module II (10 hours)

Isentropic flow of an ideal gas: General features and governing equations- stagnation properties and state- Reference velocities- Dimensionless velocity- Crocco number- Bernoulli equation- Isentropic flow through variable area- Comparison of isentropic and adiabatic flow- Mach number variations- Area ratio- Impulse function- Mass flow rate, Chocking in Isentropic flow- Variation of flow parameters in isentropic flow- Performance of convergent and De lavel nozzle- Performance of real nozzles- Applications of Isentropic flow.

Module III (10 hours)

Simple frictional flow: Governing equations- Fanno curves- Limiting conditions- Fanno flow equations- Variation of flow properties- Variation of Mach number with duct length- Choking due to friction. Isothermal flow with friction: Basic equations- Limiting conditions- Variation of flow properties. Flow with heat transfer: Governing equations- Rayleigh curves- Limiting condition- Rayleigh flow relations- Variation of flow properties- Maximum heat transfer- Thermal choking.

Module IV (9 hours)

Normal shock: Development of a shock wave- Governing equations- Intersection of Fanno and Rayleigh lines- Prandtl-Meyer relation- Properties of flow across normal shock- Thickness of shock waves- Shock strength- Determination of Mach number of supersonic flow- Variation of flow parameters through normal shock.

Module V (9 hours)

Air craft propulsion: Types of gas turbine engines- Components of a gas turbine engine- Energy flow through jet engines- Propeller and jet Thrust- propulsive and overall efficiency- Ramjet, Pulsejet and Scramjet engine. Rocket Propulsion: Types of rocket engines- Liquid propellant

rockets and propellant feed system- Solid propellant rocket motors- Restricted and unrestricted burning- Rocket propulsion theory- Applications.

Text Books

1. S M Yahya, *Fundamentals of compressible flow with aircraft and rocket propulsion*, New Age International.
2. P Balachandran, *Fundamentals of compressible fluid dynamics*, Prentice Hall of India.
3. V Babu, *Fundamentals of gas dynamics*, Ane Books India.

Reference Books

1. A. H. Shapiro, *Dynamics and thermodynamics of compressible fluid flow (Vol-1)*, The Ronald Press Company.
2. Anderson, *Modern compressible flow with historical perspective*, Mc Graw Hill
3. James John & Theo Keith, *Gas Dynamics*, Pearson International.
4. Liepmann and Roshko, *Elements of gas dynamics*, Dover publications.
5. Zucrow M. J. & Jeo D Holfman ,*Gas dynamics (Vol 1)*, John Wiley

ME010 704: Refrigeration and Air Conditioning
(Common with AU010 704)

Teaching scheme **Credits:** 3

2 hours lecture and 1 hour tutorial per week

Objectives

- *To impart the basic concepts of Refrigeration and Air Conditioning*
- *To develop a sound physical understanding of the subject so that the learner will demonstrate the ability to design a refrigeration or air-conditioning equipment that meets the required specifications*

Module 1 (8 hours)

Principles of refrigeration: Thermodynamics of refrigeration – Carnot, reversed carrot cycle, heat pump, and refrigerating machine- coefficient of performance -unit of refrigeration- refrigeration methods - conventional refrigeration systems. Air refrigeration system -Bell Coleman cycle -C.O.P –capacity, work and refrigerant flow requirements in Bell Coleman cycle.

Module 2 (10 hours)

Vapor compression system: simple cycle -comparison with Carnot cycle, theoretical and actual cycles- COP- effect of operating parameters on COP- wet, dry and superheated compression- sub cooling - actual cycle representation on TS and PH diagrams- simple problems. Advanced vapor compression systems – multistage vapor compression systems- flash chamber- multiple compression and evaporation systems- cascading -simple problems.

Module 3 (10 hours)

Vapor absorption systems: simple cycles-actual cycle- ammonia water and lithium bromide water systems – COP -Electrolux system. Refrigerant and their properties: Nomenclature- suitability of refrigerants for various applications -unconventional refrigeration methods- vortex tube, steam jet, magnetic (Cryogenics) refrigeration and thermoelectric refrigeration- applied refrigeration: house hold refrigerator –unit air conditioners and water coolers- ice plant -cold storage

Module 4 (7 hours)

Refrigeration system components (Theory Only): water and air cooled condensers- evaporative condensers- expansion devises -capillary tube -constant pressure expansion valve- thermostatic expansion valve- float valve and solenoid valve. Evaporators: natural convection coils -flooded evaporators -direct expansion coils. Reciprocating compressors: single stage and multistage compressors- work done -optimum pressure ratio -effect of intercooling- volumetric efficiency -

effect of clearance- isothermal and adiabatic efficiency. Rotodynamic compresors: Screw and vane type compressors- principle of operation- hermetic, semi hermetic and open type refrigeration compressors.

Module 5 (10 hours)

Principles of air conditioning: Psychrometry and psychrometric chart - human comfort- effective temperature- comfort chart. Applied psychrometry: sensible heat factor- psychometric process – problems. Winter air conditioning- heating load calculations- humidifiers and humidistat. Summer air conditioning- cooling load calculations- year round air conditioning -unitary and central systems -principles of air distribution -design of air duct systems.

Text Books

1. Stoecker W.F. and Jones J.W, *Refrigeration and Air-Conditioning*, McGraw- Hill
2. Jordan and Prister, *Refrigeration and Air-Conditioning,* Prentice Hall of India.

Reference Books

1. Dossat., *Principles of Refrigeration*, John Wiley and Sons
2. Robert H. Enerick, *Basic Refrigeration and Air-Conditioning*, Prentice Hall.
3. Arora C.P., *Refrigeration and Air-Conditioning*, Tata McGraw- Hill

ME 010 705: Industrial Engineering
(Common with AU010 705)

Teaching scheme **Credits:** 4

2 hours lecture and 1 hour tutorial per week

Objectives

- *To provide an exposure to the fundamental tools and techniques in Industrial Engineering for integration and improvement of inter related work activities and productivity management.*

Module I (9 hours)

Introduction: Evolution of industrial Engineering, Branches and Fields of application of Industrial Engineering, Functions of Industrial Engineer. Types of production- Productivity- Productivity index- factors affecting productivity-techniques for productivity improvement.

Product development and design: Requirements of a good product design- product development process- product analysis. Value Engineering: Fundamental Concepts- reasons for poor values- types of values- Applications and benefits of Value Engineering.

Module II (9 hours)

Facility planning: Plant location-Procedure for site selection- Plant layout-Objectives and principles of plant layout- types of layout- Factors influencing layout- introduction to layouts based on group technology, just-in-time and cellular manufacturing systems.

Material Handling: Functions and Principles of material handling, Selection of material handling equipments-types of material handling equipments.

Module III (9 hours)

Materials Management: Objectives, functions and scope of materials management. **Purchasing** - Objectives and functions-purchasing procedure- buying techniques- Vendor development and rating system- Stores management.

Inventory Control: Objectives of inventory control-inventory costs-Determining inventory level- EOQ model-Models with shortages-Continuous and Periodic Review systems-ABC analysis- Make or buy decision-Vendor Managed Inventory.

Module IV (9 hours)

Methods engineering: Work study-Procedure for motion study- Recording Techniques- Micro motion study- Work measurement techniques- Time study.

Industrial Ergonomics: Introduction to Ergonomics-Objectives of Human Engineering- Aspects of Man- Machine System- Workplace design.

Job Evaluation and Merit Rating: Objectives of Job evaluation, methods of job evaluation, merit rating, Types of merit rating.

Module V (9 hours)

Inspection and Quality Control: Objectives and kinds of inspection-methods of inspection-Objectives of quality control- Statistical quality control-control charts, problems- Acceptance sampling-Total quality management- ISO systems-QFD- Benchmarking.

Text Books

1. Verma A.P., *Industrial Engineering,* S. K. Kataria & Sons.
2. Sharma S. C. & Banga T. R., *Industrial Organization and Engineering Economics,* Khanna Publishers.

Reference Books

1. Tompkins J.A and White J.A. , *Facilities Planning,* John Wiley, N.Y.,1984.
2. Tony Arnold, J.R, *Introduction to materials management,* Prentice hall inc, N.J,1998.
3. Tayyari and Smith J.L., *Occupational Ergonomics; principles and Applications*, Chapman and Hall publication, U.K., 1997

ME 010 706 L01: PLANT ENGINEERING AND MAINTENANCE

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Objectives

- *The course is designed to develop an understanding of maintenance tools and techniques in the new industrial world.*

Module 1 (12 hours)

Fundamentals of plant engineering - Plant facilities - Layout of facilities, basic amenities etc. Types of maintenance- breakdown, preventive, periodic or predictive, condition based maintenance- deterioration and failure analysis- planning, scheduling, and controlling of maintenance work- organization for maintenance.

Module 2 (12 hours)

Wear: Sliding wear tests – Archard wear equation – unlubricated wear of metals - wear regime maps for metals – mechanism of sliding wear of metals : plasticity dominated wear, Oxidative wear – lubricated wear of metals – fretting wear of metals – wear of ceramics and polymers.

Module 3 (12 hours)

Reliability: concept and definition-chance failure and wear out failure -application of stochastic model for reliability studies- reliability of series, parallel and stand by systems- estimation of parameters of failure distribution- maintainability and availability.

Replacement: causes of deterioration and obsolescence- sudden and gradual obsolescence and deterioration- economic analysis- MAPI method- simple problems.

Module 4 (12 hours)

Condition based maintenance using Vibration Signature, SOAP, ferrography, hot ferrography, Infra Red Camera, fluorescent dye, Particle Analyzers and other diagnostic techniques.

Reliability Centered Maintenance- Total Productive Maintenance- Tero-technology and its influence on plant engineering and maintenance. Overall equipment effectiveness (OEE) – Reliability Availability and Maintainability analysis (RAM).

Module 5 (12 hours)

Safety management: fire protection and prevention - safety against mechanical hazards, chemical hazards- accident prevention program- Industrial noise - Pollution control- Waste disposal - Recycling of waste - Energy conservation, management and audit - legal provisions for safety in industry.

Text Books

1. Collacott R.A., *Mechanical fault Diagnosis and Condition Monitoring*, Chapman and Hall Ltd.
2. Sushikumar Srivastava, *Industrial Maintenance Management*, S. Chand and Co. Ltd., New Delhi.

Reference Books

1. Rosaler R., *Handbook of Plant Engineering*, McGraw Hill.
2. Mobley K., Higgins L.R., *Handbook of Maintenance Engineering*, McGraw Hill.
3. Hutchings I. M., *Trobology: friction and wear of engineering materials*, Edward Arnold
4. Robinowicz Ernest, *Friction and wear of materials*, John Wiley

ME010 706L02: Turbo Machines

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Objectives

- *To impart the basic concepts of various turbo machines like blowers, fans, compressors and turbines.*

Module I (12 hours)

Principles: Energy transfer between fluid and rotor, classification of fluid machinery, dimensionless parameters, specific speed, applications, stage velocity triangles, work and efficiency for compressors and turbines.

Module II (12 hours)

Centrifugal Fans and Blowers: Types, stage and design parameters, flow analysis in impeller blades, volute and diffusers, losses, characteristics curves and selection, fan drives and fan noise.

Module III (12 hours)

Centrifugal Compressor: Construction details, types, impeller flow losses, slip factor, diffuser analysis, losses and performance curves.

Module IV (12 hours)

Axial Flow Compressor: Stage velocity triangles, enthalpy-entropy diagrams, stage losses and efficiency, work done factor, simple stage design problems and performance characteristics.

Module V (12 hours)

Axial and Radial Flow Turbines: Stage velocity diagrams, reaction stages, losses and coefficients blade design principles, and testing and performance characteristics.

Text Books

1) Yahya, S.H., *Turbines, Compressor and Fans*, Tata Mc Graw Hill Publishing Company, 1996.
2) B K Venkanna, *Fundamentals of Turbomachinery*, Prentice Hall of India, 2009

Reference Books

1. Bruneck, *Fans*, Pergamom Press, 1973.
2. Earl Logan, Jr., *Hand book of Turbomachinery*, Marcel Dekker Inc., 1992.
3. Dixon, S.I., *Fluid Mechanics and Thermodynamics of Turbomachinery*, Pergamom Press, 1990.
4. Shepherd, D.G., *Principles of Turbomachinery*, Macmillan, 1969.
5. Stepanff, A.J., *Blowers and Pumps*, John Wiley and Sons Inc., 1965
6. Ganesan .V. *Gas Turbines*, Tata Mcgraw Hill Pub.Co., New Delhi, 1999.

ME010 706 L03 Theory of vibration

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Objectives

- *To understand the basic concepts and issues related to vibration*

Module I (12 hours)

Fundamentals of vibration

Introduction, Definitions, Vector method of representing harmonic motions, Additions of two Simple Harmonic Motions of the same Frequency, Beats Phenomenon.

Undamped free vibrations of single degree of freedom

Introduction, Derivation of differential equation, Solution of differential equation, Torsional Vibrations, equivalent stiffness of Spring Combinations, Energy Method.

Module II (12 hours)

Damped free vibrations of single degree of freedom system

Introduction, Different types of Damping, Free Vibrations with viscous damping, Logarithmic decrement, Viscous dampers, Dry Friction or Coulomb damping, Solid or Structural damping.

Module III (12 hours)

Forced vibrations with constant harmonic excitation

Introduction, Forced Vibrations with constant harmonic excitation, Forced Vibrations due to excitation of the Support, Energy dissipated by damping, Forced vibrations with Coulomb damping, Forced vibrations with Structural damping, Determination of Equivalent viscous damping from frequency-response curve, Vibration isolation and transmissibility, Vibration measuring instruments, Critical speed of shafts

Module IV (12 hours)

Two degree of freedom systems

Introduction, Principal modes of Vibration, Other cases of simple two degrees of freedom systems, Combined rectilinear and angular modes, Systems with damping, Undamped forced

vibrations with Harmonic excitation, Vibration absorbers, Vibration Isolation Natural frequencies and mode shapes (eigenvalues and eigenvectors), orthogonal properties of normal modes, Introduction to Model analysis,

Module V (12 hours)

Continuous systems – vibrating strings - axial vibration of rod – transverse vibration of beams – torsional vibration of shafts.

Text Books

1. Leonard Meirovitch, "Fundamentals of Vibrations", International Edition, McGraw-Hill, 2001.

2. Singiresu S Rao, “Mechanical Vibrations", Fourth Edition, Pearson.

3. V. P. Singh, “Mechanical Vibrations", Dhanpat Rai & sons

4. William T Thomson, “Theory of Vibration with applications", Prentice Hall, 1993.

ME010 706 L04 Sales and Marketing Management

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Module 1 (12 hours)

Marketing: Definition- Marketing concepts- Market segmentation- Market demand- Product- Value and satisfaction- Exchange and transactions- Marketing channels- Competition- Marketing environment- Marketing mix.
Marketing Management: Functions-Sales forecasting-Pricing-Distribution- Advertising- Sales promotion- Marketing research.

Module 2 (12 hours)

Strategic Planning: Strategic business unit (SBU)- Business strategic planning- SWOT analysis. Marketing decision support system.

Module 3 (12 hours)

Product life cycle: Marketing strategies in the different stages of product life cycle.
New product development: Idea generation- Concept development and testing conjoint analysis.
Introduction to Relationship marketing, International marketing and on line marketing.

Module 4 (12 hours)

Consumer behaviour: Major factors affecting consumer buying behavior- Consumer decision making process.
Organizational buying behavior: Buying situations- the buying center-Purchasing process.

Module 5 (12 hours)

Sales management: Evolution of Sales management- Objectives of Sales management- Personal selling situations- Theories of selling- Basic selling styles- Recruitment, selection and training of sales personnel-Sales territory-Sales quotas.

References

1. Marketing Management - Philip Khotler
2. Sales Management - Richard, Edward & Norman
3. Industrial Engg & Management - O.P.Khanna
4. Industrial Organisation & Management - Banga & Sarma
5. Organisational Behaviour - Fred Luthans

6. Consumer Behaviour - Schifman & Kanuk
7. Basic marketing - Gundiff
8. Marketing Management for small units - Jain
9. Sales Engg - Lester
10. Salesmanship concept - Thomson

ME010 706 L05 Failure Analysis and Design

Teaching scheme **Credits:** 4

2 hours lecture and 2 hours tutorial per week

Objectives:

- *To introduce basic concepts of reliability in analysis and design*
- *To study fracture, fatigue and other modes of failure*

Module1 (12 hours)

Reliability: Reliability concept and hazard function, life prediction, condition monitoring, application of Poisson, exponential and Weibull distribution for reliability - bath tub curve - parallel and series system - mean time between failures and life testing.

Stresses in a body: Two dimensional and three dimensional state of stress, Mohr's circle two and three dimensions, hydrostatic stress, Von-mises, maximum shear stress (Tresca), octahedral shear stress, torsional stresses for large plastic strain.

Module 2 (12 hours)

Fracture: Types of fracture, Griffith crack theory, stress analysis of cracks, metallographic aspects of fracture. Brittle, ductile fractures, notch effects, fracture curve, R curve, fracture under combined stresses, effect of hydrostatic pressure on fracture, probabilistic aspects of fracture mechanics, toughness of materials.

Module 3 (12 hours)

Fatigue: Statistical nature of fatigue, S-N curve, low cycle fatigue, strain life equations, structural feature of fatigue, fatigue crack propagation, effect of stress concentration, size, surface properties, metallurgical variables on fatigue, case studies, designing against fatigue, detail design, improvements after failure and service, fatigue of bolts, welded and adhesive joints.

Fatigue tests: Purpose, specimen, fatigue test procedures, evaluation of fatigue test results, crack growth measurement.

Module 4 (12 hours)

Wear failures: Type of wear, role of friction in wear, lubricated and non-lubricated wear, analysing wear failures, wear tests SOAP, ferrography.

Corrosion failures: Factors influencing corrosion failures, analysis of corrosion failures, overview of various types of corrosion, stress corrosion cracking - sources, characteristics of stress corrosion cracking, procedure of analysing stress corrosion cracking, various types of hydrogen damage failures, corrective and preventive action.

Module 5 (12 hours)

Elevated temperature failures: Creep, stress rupture, elevated temperature fatigue, metallurgical instabilities, environmental induced failure, elevated temperature effects on certain gas turbine components and petroleum refinery components, tests for analysis of failure at elevated temperatures.

References

1. Jaap Schijve, “Fatigue of Structures and Materials”, Kluwer Academic Publishers, 2001.
2. ASM Metals Handbook, "Failure Analysis and Prevention", ASM Metals Park, USA, Vol. 10, 10th Edition, 1995.
3. Richard W Hertzberg,“Deformation and Fracture Mechanism of Engineering Materials”,John Wiley & Sons,Inc.,1995.
4. George E Dieter, “Mechanical Metallurgy”, McGraw Hill Book Company, 1988.

ME 010 706 L06 Foundary and Welding Technology

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Foundary Technology

Module 1 (12 hours)

Degassing: Gas Porosity – **Molten Metal Filtration**: sources of inclusions, methods for removal of inclusions – **Castability**: factors influencing fluidity, hot tearing - **Semisolid Metal Processing** - viscosity evolution during continuous cooling - **Rapid Solidification**: microstructural modification, heat flow - **Solidification during Casting of Metal-Matrix Composites**:- incorporation of reinforcements, reinforcement-metal wettability, solidification, distribution of reinforcements.

Module 2 (12 hours)

Hot Isostatic Pressing of Castings:- Reasons for using HIP, effect of HIP on mechanical properties, effect of HIP on the shape and structure of castings, problems encountered in HIP, economics of HIP – **Low Pressure Metal Casting**:- conventional methods, low-pressure furnace and tooling, cores, vacuum riserless/pressure riserless casting – **High Pressure Die Casting**:- die casting alloys and processes, hot and cold chamber, advantages, disadvantages - **Hot and Cold Chamber Die Casting**:- melting process, injection components, distinctions between hot and cold chamber processes, gate and runner design, temperature control.

Module 3 (12 hours)

Vacuum High-Pressure Die Casting:- vacuum riserless casting, high-vacuum die casting – **Semisolid Casting** (SSM):introduction, fundamentals: advantages of SSM processing, SSM processing - **Aluminum and Aluminum Alloy Castings**: effects of alloying and impurity elements, structure control, secondary dendrite arm spacing, nondendritic microstructures, grain structure, grain-refinement, welding, molten metal fluidity, hot cracking - **Titanium and Titanium Alloy Castings**: effects of alloying elements, microstructures of titanium castings, cast microstructure of Ti - 6Al - 4V, melting and pouring, molding methods, postcasting practice, welding, heat treatment **- Nickel and Nickel Alloy Castings**: structure and property correlations, melting practice and metal treatments, foundry practice, pouring practice, gating systems, risers, welding, heat treatment and applications.

Welding Technology

Module 4 (12 hours)

Heat Flow in Fusion Welding - Fluid flow phenomena during Welding: mass transport in the arc in gas tungsten arc welding, deep-penetration electron beam and laser welds, in gas metal arc welding, in submerged arc welding.

Module 5 (12 hours)

Transfer of Heat and Mass to the base metal in gas metal arc welding - Arc Physics of Gas - Tungsten Arc Welding: electrode regions and arc column - Introduction to **Special Welding processes**: **Underwater** Welding: underwater welding pyrometallurgy, micro structural

development of underwater welds, heat sources, applications - welding for **cryogenic** service - welding in **space** and low - gravity environments: metallurgy of low-gravity welds.

TEXT BOOKS:

1. ASM Handbook, Volume 15, Casting, ASM International, Metals Park, Ohio, USA.
2. ASM Metals Handbook. Volume 6, Welding Brazing and Soldering, ASM International, Metals Park, Ohio, USA, 1993.

REFERENCE BOOKS:

1. Amstead B.H., Phillip E Ostwald and Myron L.Begeman, "Manufacturing Processes" John Wiley & Co., New York.
2. American Welding Society, Welding handbook, Vol. 1 and 2, 7th edition.
3. AWS Welding Handbooks, AWS, New York, 1995.
4. Flimm, Fundamentals of Metals Casting, Addison Wesley.
5. Gourd L.M., Principles of Welding Technology, ELBS/ Edward Arnold.
6. Howard B Cary., Modern Welding Technology, 4th edition, Prentice Hall, New Jersey, USA, 1997.
7. Koenigsberger and Adaer, Welding Technology, Macmillan.
8. Lancaster, The Physics of Welding; Pergaman Press.
9. Lancster and George Allen, The Metallurgy of Welding, Unwin Ltd. U.K.
10. Lincoln Electric Co, Procedure Handbook of ARC Welding; Lincoln Electric Co. USA.
11. Richard W.Heine, Carl R.Loper and Phlip C.Rosenthal, "Principles of Metal Casting", Tata McGraw Hill, New Delhi.
12. Rossi, Welding Technology, McGraw Hill.
13. Salman and Simans, Foundry Practice, Issac Pitman.
14. Tylecote, The Solid Phase Welding of Metals, Edward Arnold Pvt. Ltd.

ME 010 707 Mechanical Measurements Laboratory

Teaching scheme **Credits:** 2

3 hours practical per week

Objectives

- *To provide an exposure to the fundamentals of metrology*
- *To understand the need of precision measurement and measuring instruments*

1. Study and use of laser interferometer for calibration of linear measurements.
2. Study of slip gauges – wringing – surface roughness - standards.
3. Study of surface plates, straight edges, angle plate, V-block etc and applications.
4. Measurement of out of roundness using roundness measuring instrument, V block and dial indicator etc. - reasons for out of roundness etc.
5. Measurements of straightness using sprit level and auto collimator.
6. Measurement of thread parameters using three wire method.
7. Measurement of tool angles of single point tool using tool maker's microscope.
8. Measurement of gear parameters using profile projector.
9. Evaluation of straightness error using autocollimator, sprit level, straight edge etc.
10. Calibration and determination of uncertainties of the following;
    a. Strain gauge load cells
    b. Bourdon tube pressure gauge
    c. LVDT
    d. Thermocouples
    e. Tachometers and stroboscopes, etc.
11. Study and measurement of surface roughness using surface roughness instrument.
12. Study and measurements with coordinate measuring machines.
13. Experiments on limits and fits.
14. Study and use of ultrasonic flaw detector.
15. Study of different types of dial indicators - stands and holders for dial gauges.
16. Study and use of different types of comparators.
17. Exercises on measurement system analysis
18. Study and making measurements with precision vernier calipers, dial calipers, spline micrometer, point micrometer, wire groove micrometer, depth micrometer, V- anvil micrometers, depth gear tooth micrometer, thread micrometer, disc micrometer, thread pitch gauge, vernier height gauge, slip gauges, optical flat, three pin micrometer,

pyrometer, RTD, bore dial gauge, depth gauge, pitch gauge, thickness gauge, radius gauge, hole test, bench center etc.

19. Angular measurements using bevel protractor, sine bar, clinometers etc.
20. Measurement of vibration.
21. Analysis of automobile exhaust gas and flue gas.
22. Study and determination of area using planimeter.
23. Polishing, etching and determination of grain size and microstructure studies using optical microscope.

TEXT BOOKS:

1. Sharp K.W.B., Practical Engineering Metrology, Sir Isaac Pitman and sons Ltd, London, 1958.
2. Shotbolt C.R. and Gayler J.F.W, Metrology for Engineers, 5th edition, ELBS, London.

REFERENCE BOOKS:

1. Figliola, Richard S, and Beasley, Donald E, “Theory and Design for Mechanical Measurements”, Third edition, John Wiley and Sons Inc.
2. Collett, C.V. and Hope, A.D, “Engineering Measurements”, Second edition, ELBS/Longman.
3. Tarasevigh Y. and Yavosih E., Fits, Tolerances and Engineering Measurements, Foreign language publishing house, Moscow.

ME 010 708 Advanced Machine Tools Laboratory

Teaching scheme **Credits:** 2

3 hours practical per week

Objectives

- *To understand the different process parameters involved in shaping, slotting, milling, grinding machines.*
- *To analysis the causes for the variation on surface roughness obtainable in different machining process.*

PART – A

1. Experiment on shaping machine: - flat surfaces, dovetail cutting – grooving, keyway cutting etc. **- 2 practices.**

2. Experiment on slotting machine: - flat surfaces, dovetail cutting – grooving, keyway cutting etc. - making hexagonal hole using slotting machine. **- 2 practices.**

3. Study of milling machines – nomenclature of milling cutters – different types of milling cutters – attachments for milling:- vertical milling and universal milling attachment, high speed milling attachment, rack milling and slot attachments, parking bracket, rotary table, universal dividing head, vices, arbors, adaptors and collet chucks. **- 1 practice.**

4. Experiment on milling machine: - 1 - plane milling, keyway cutting, cutting of splines. **- 1 practice.**

5. Experiment on milling machine: - 2 – cutting of spur, helical and bevel gears – study of different methods of indexing - multi slot cutting on milling machine by indexing. **- 3 practices.**

6. Study of surface grinding machine and demonstration of grinding of plane surface - study of cylindrical grinding machine and demonstration of plane cylindrical grinding – study and demonstration of planing machine – study and demonstration of broaching machine. **- 2 practices.**

PART – B

Preparation of control charts - preparation of laboratory layout - facilities layout analysis– materials requirement planning – inventory analysis –preparation of process plan and cost estimation for the manufacture of various products – study of a jig and a fixture for drilling and milling operation - fabrication of simple bending dies – Preparation of process plans using CAPP software. **- 3 practices.**

Besides to the skill development in performing the work, oral examination should be conducted.

A detailed report on the work carried out on part – B is also to be prepared. Observation and record books are to be maintained for both part A and B.

The student's assessment, continuous evaluation, awarding of sessional marks, record bonafides, oral examination etc and University examination shall be carried out by the faculty members (Assistant professor and above).

TEXT BOOKS:

1. Acharkan. N., Machine Tool Design Vol. 1 to 4, MIR Publication.

REFERENCE BOOKS:

1. Chapman, Workshop Technology, Vol II, ELBS.
2. HMT, Production Technology, Tata McGraw Hill.
3. Yoram Koren, Numerical Control of Machine Tools, McGraw-Hill.

ME 010 709 Seminar

Teaching scheme **credits: 2**

2 hours practical per week

The seminar power point presentation shall be fundamentals oriented and advanced topics in the appropriate branch of engineering with references of minimum seven latest international journal papers having high impact factor.

Each presentation is to be planned for duration of 25 minutes including a question answer session of five to ten minutes.

The student's internal marks for seminar will be out of 50. The marks will be awarded based on the presentation of the seminar by the students before an evaluation committee consists of a minimum of 4 faculty members. Apportioning of the marks towards various aspects of seminar (extent of literature survey, presentation skill, communication skill, etc.) may be decided by the seminar evaluation committee.

A bona fide report on seminar shall be submitted at the end of the semester. This report shall include, in addition to the presentation materials, all relevant supplementary materials along with detailed answers to all the questions asked/clarifications sought during presentation. All references must be given toward the end of the report. The seminar report should also be submitted for the viva-voce examination at the end of eighth semester.

For Seminar, the minimum for a pass shall be 50% of the total marks assigned to the seminar.

ME 010 710 Project Work

Teaching scheme **credits: 1**

1 hour practical per week

Project work, in general, means design and development of a system with clearly specified objectives. The project is intended to be a challenge to intellectual and innovative abilities and to give students the opportunity to synthesize and apply the knowledge and analytical skills learned in the different disciplines.

The project shall be a prototype; backed by analysis and simulation etc. No project can be deemed to be complete without having an assessment of the extent to which the objectives are met. This is to be done through proper test and evaluation, in the case of developmental work, or through proper reviews in the case of experimental investigations.

- The project work has to be started in the seventh semester and to be continued on to eighth semester.
- Project work is to be done by student groups. Maximum of four students only are permitted in any one group.
- Projects are expected to be proposed by the students. They may also be proposed by faculty member (Guide) or jointly by student and faculty member.
- Students are expected to finalise project themes/titles with the assistance of an identified faculty member as project guide during the first week of the seventh semester.

The progress from concept to final implementation and testing, through problem definition and the selection of alternative solutions is monitored. Students build self confidence, demonstrate independence, and develop professionalism by successfully completing the project.

Each student shall maintain a project work book. At the beginning of the project, students are required to submit a project plan in the project book. The plan should not exceed 600 words but should cover the following matters.

- ❖ Relevance of the project proposed
- ❖ Literature survey
- ❖ Objectives
- ❖ Statement of how the objectives are to be tackled

- Time schedule
- Cost estimate

These proposals are to be screened by the evaluation committee (EC- minimum of 3 faculty members including the guide) constituted by the head of department, which will include a Chairman and the EC will evaluates the suitability and feasibility of the project proposal. The EC can accept, accept with modification, request a resubmission, or reject a project proposal.

Every activity done as part of project work is to be recorded in the project book, as and when it is done. Project guide shall go through these records periodically, and give suggestions/comments in writing in the same book.

The students have to submit an interim report, along with project work book showing details of the work carried out by him/her and a power point presentation at the end of the 7^{th} semester to EC. The EC can accept, accept with modification, request a resubmission, or extension of the project.

The student's internal marks for project will be out of 50, in which 30 marks will be based on day to day performance assessed by the guide. Balance 20 marks will be awarded based on the presentation of the project by the students before an evaluation committee consists of a minimum of 3 faculty members including the guide.

For Project, the minimum for a pass shall be 50% of the total marks assigned to the Project work.

ME010 801 Design of Transmission Elements
(Common with AU010 801)

Teaching scheme **Credits:** 4

2 hours lecture, 2 hour tutorial and 1 hour drawing per week

Objectives

To provide basic design skill with regard to various transmission elements like clutches, brakes, bearings and gears.

Module I (20 Hrs)

Clutches - friction clutches- design considerations-multiple disc clutches-cone clutch- centrifugal clutch - Brakes- Block brake- band brake- band and block brake-internal expanding shoe brake.

Module II (17 Hrs)

Design of bearings - Types - Selection of a bearing type - bearing life - Rolling contact bearings - static and dynamic load capacity - axial and radial loads - selection of bearings - dynamic equivalent load - lubrication and lubricants - viscosity - Journal bearings - hydrodynamic theory - design considerations - heat balance - bearing characteristic number - hydrostatic bearings.

Module III (19 Hrs)

Gears- classification- Gear nomenclature - Tooth profiles - Materials of gears - design of spur, helical, bevel gears and worm & worm wheel - Law of gearing - virtual or formative number of teeth- gear tooth failures- Beam strength - Lewis equation- Buckingham's equation for dynamic load- wear load- endurance strength of tooth- surface durability- heat dissipation - lubrication of gears - Merits and demerits of each type of gears.

Module IV (16 Hrs)

Design of Internal Combustion Engine parts- Piston, Cylinder, Connecting rod, Flywheel

Design recommendations for Forgings- castings and welded products- rolled sections- turned parts, screw machined products- Parts produced on milling machines. Design for manufacturing - preparation of working drawings - working drawings for manufacture of parts with complete specifications including manufacturing details.

Note: Any one of the following data book is permitted for reference in the final University examination:

1. Machine Design Data hand book by K. Lingaiah, Suma Publishers, Bangalore/ Tata Mc Graw Hill
2. PSG Design Data, DPV Printers, Coimbatore.

Text Books

1. C.S,Sarma, Kamlesh Purohit, Design of Machine Elements Prentice Hall of India Ltd NewDelhi
2. V.B.Bhandari, Design of Machine Elements McGraw Hill Book Company
3. M. F. Spotts, T. E. Shoup, Design of Machine Elements, Pearson Education.

Reference Books

1. J. E. Shigley, Mechanical Engineering Design, McGraw Hill Book Company.
2. Juvinall R.C & Marshek K.M., Fundamentals of Machine Component Design, John Wiley
3. Doughtie V.L., & Vallance A.V., Design of Machine Elements, McGraw Hill Book Company.
4. Siegel, Maleev & Hartman, Mechanical Design of Machines, International Book Company.

ME010 802 Operations Management
(Common with AU010 802)

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Objectives

- *To familiarize the main decision making scenarios (strategic, tactical and operative) an Operations Manager may come across.*
- *To develop an understanding of the main OM principles, techniques and tools to analyze, diagnose and then to improve processes.*

Module I (12 hours)

Introduction to Operations Management- Functions of Operations Management, Strategic, Tactical and Operational decisions. Forecasting in decision making: Factors affecting forecasting, Sources of data, Time series analysis, Demand patterns, Forecasting methods- Moving average, Regression, Exponential smoothing-problems, Qualitative methods- Measures of forecast accuracy.

Module II (12 hours)

Aggregate Planning: Aggregate planning strategies and methods, Transportation model for aggregate planning. Master Production Schedule- Materials Requirement Planning, Bill of materials, Lot sizing in MRP, MRP-II, CRP, DRP.

Module III (12 hours)

Introduction to Scheduling: Single machine scheduling, Flow shop scheduling, Job shop scheduling. Sequencing: Johnson's algorithm, Processing *n* jobs through two machines, processing *n* jobs through three machines, processing *n* jobs through *m* machines, processing two Jobs through *m* machines-problems.

Module IV (12 hours)

Maintenance Planning and Control: Types of maintenance, Need for replacement, Replacement problems, Individual replacement policy, Group replacement policy, TPM. Reliability – Bath tub curve- reliability improvement, Measures for maintenance performance, reliability calculations, FMECA, information system for maintenance management.

Module V (12 hours)

Modern concepts/ techniques in operations management: Just in time manufacturing, Lean manufacturing, Push Pull Production, Kanban systems, Flexible manufacturing systems, ERP.

Supply Chain management: Supply chain, objective of Supply Chain, Supply chain macro processes, Process view of a supply chain, Drivers of Supply Chain.

Text Books

1. Mahadevan B., *Operations Management*, Pearson Education.
2. Panneerselvam R., *Production and operations Management*, Prentice Hall of India.

Reference Books

3. Krajewski and Ritzman, *Operations Management*, Pearson Education.
4. Verma A.P., *Industrial Engineering*, S. K. Kataria & Sons.
5. Adam and Ebert, *Production and Operations Management*, Prentice Hall of India.
6. Chopra and Meindl, *Supply Chain Management*, Prentice Hall of India.

ME 010 803 Production Engineering

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Module 1 (12 hours)

Theory of metal cutting: Scenario of manufacturing process – Deformation of metals, Schmid's law (review only) – Performance and process parameters – single point cutting tool nomenclature - attributes of each tool nomenclature - attributes of feed and tool signature on surface roughness obtainable, role of surface roughness on crack initiation - Oblique and orthogonal cutting – Mechanism of metal removal - Primary and secondary deformation shear zones - Mechanism of chip formation, card model, types of chip, curling of chips**,** flow lines in a chip, BUE, chip breakers, chip thickness ratio – Mechanism of orthogonal cutting: Thin zone and thick zone, Merchant's analysis – shear angle relationship, Lee and Shaffer`s relationship, simple problems – Friction process in metal cutting: nature of sliding friction, columb`s law, adhesion theory, ploughing, sub-layer flow – Empirical determination of force component.

Module 2 (12 hours)

Thermal aspects of machining: Source of heat, temperature distribution pattern in chip, shear plane and work piece, effect of speed, feed and depth of cut – tool temperature measurement - **Tool materials**: properties of tool material, Carbon steel, HSS (classification, structure, composition, properties) - cemented Carbides (structure, properties), indexable inserts, coated WC, cermets – alumina (ceramic), sialon, cubic Boron Nitride (cBN), diamond, diamond coated tools – **Tool wear**: flank and crater wear – Tool **wear mechanisms**: adhesion, abrasion, diffusion and fatigue – **Tool life**, Taylor's equation, applications - effect of rake angle, clearance angle, chip temperature and cutting time on tool life, simple problems - Tool **wear criterion**: allowable wear land etc - **Economics** of machining – **machineability** of Ti, Al, Cu alloys and machineability index – cutting force (quartz crystal dynamometer) - **Cutting fluids**: effect of specific heat on selection of fluids, functions, classifications, specific applications.

Module 3 (12 hours)

Powder Metallurgy: **Need** of P/M - **Powder Production** methods:- Atomization, electrolysıs, Reduction of oxides, Carbonyls (Process parameters, characteristics of powder produced in each method) – **Powder characteristics**: properties of fine powder, size, size distribution, shape, compressibility, purity etc.- **Mixing** – **Compaction**:- techniques, pressure distribution, HIP & CIP, – Mechanism of **sintering,** driving force, solid and liquid phase sintering - Impregnation and Infiltration Advantages, disadvantages and specific applications of P/M.

Micromachining: Diamond turn mechanism, material removal mechanism- Magnetorheological nano-finishing process: - polishing fluid, characteristics of MRP fluid, MRF and MRAFF process.

Module 4 (12 hours)

Ceramic Structures and properties**: -** coordination number and radius rations - AX, A_mX_p, $A_mB_mX_p$ type crystal structures – imperfections in ceramics- phase diagrams of Al_2O_3 – Cr_2O_3 and MgO- Al_2O_3 only – mechanical properties – mechanisms of plastic deformation – ceramic application in heat engine, ceramic armor and electronic packaging.

Fundamentals of **Composites: -** particle reinforced composites **–** large particle composites - fiber reinforced composites: influence of fiber length, orientation and concentration-fiber phase – matrix phase.

Module 5 (12 hours)

Advanced production methods: **Nontraditional machining**: EDM, ECM, USM, EBM, LBM, IBM, Abrasive water jet machining (principle, process parameters, material removal mechanism, MRR, surface roughness, HAZ and applications) – **Material addition process**:- stereo-lithography, selective laser sintering, fused deposition modeling, laminated object manufacturing, laser engineered net-shaping, laser welding, LIGA process.

TEXT BOOKS:

1. Armarego and Brown, The Machining of Metals, Prentice – Hall.
2. Bhattacharyya, Metal Cutting Theory and Practice**,** Central Publishers. Wiley
3. Paul. H. Black, Theory of Metal Cutting, McGraw Hill.

REFERENCES BOOKS:

1. ASM hand book Volume 16, Machining, ASM international, 1989
2. Boothroyd Geoffrey, Fundaments of Machining and Machine Tools, Marcel Dekker, 1990.
3. Brophy, Rose and Wulf, the Structure and Properties of Metals Vol.2, Wiley Eastern.
4. Dixon and Clayton, Powder Metallurgy for Engineers, Machinery Publishing Co. London.
5. Jain V.K., Introduction to Micromachining, Narosa publishers.
6. Juneja B.L. Fundamentals of metal cutting and machine tools, Wiley, 1987.
7. Komanduri R, Tool materials in Kirk Othmer Encyclopedia of chemical technology, 4^{th} edition, volume 24, 390, Wiley, 1997.
8. Lal G.K., Introduction to Machining Science, New Age Publishers.
9. Machining date hand book, Volume 1 and 2, Machinability date center, Cincinnati, 1990.
10. Shaw Milton C, Metal Cutting Principles, CBS Publishers.
11. Trent M. Edward, Metal Cutting, Butterworth.
12. Venkatesh V.C. and H.Chandrasekaran, Experimental techniques in metal cutting, Prentice Hall, 1987.

Electives - III

ME010 804 L01 Aerospace Engineering

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Module 1 (12 hours)

The atmosphere: Characteristics of Troposphere, Stratosphere, Mesosphere and Ionosphere - International Standard Atmosphere – Pressure, Temperature and Density variations in the International Standard Atmosphere – Review of basic fluid dynamics – continuity, momentum and energy for incompressible and compressible flows – static, dynamic and stagnation pressures – phenomena in supersonic flows

Module 2 (12 hours)

Application of dimensional analysis to 2D viscous flow over bodies – Reynolds number – Mach number similarity – Aerofoil characteristics – Pressure distribution – Centre of Pressure and Aerodynamic Center – Horse shoe vortex

Module 3 (12 hours)

Momentum and Blade Element Theories – Propeller co-efficients and charts – Aircraft engines – Turbo jet, Turbo fan and Ram Jet engines – Bypass and After Burners

Module 4 (12 hours)

Straight and Level Flight – Stalling Speed – Minimum Drag and Minimum Power conditions – Performance Curves – Gliding – Gliding angle and speed of flattest glide – Climbing – Rate of Climb – Service and Absolute Ceilings – Take off and Landing Performance – Length of Runway Required – Circling Flight – Banked Flight – High Lift Devices – Range and Endurance of Air planes.

Module 5 (12 hours)

Air speed indicators – Calculation of True Air Speed – Altimeters – Rate of Climb meter – Gyro Compass – Principles of Wind Tunnel Testing – Open and Closed type Wind Tunnels – Pressure and Velocity Measurements – Supersonic Wind Tunnels (description only) – Rocket Motors – Solid and Liquid Propellant Rockets – Calculation of Earth Orbiting and Escape Velocities Ignoring Air Resistance and assuming Circular Orbit.

References

1. Mechanics of Flight - Kermode A. C.

2. Aerodynamics for Engineering Students - Houghton and Brock
3. Airplane Aerodynamic – Dommasch
4. Anderson J.D. Jr., (2007), Fundamentals of Aerodynamics, Tata McGraw-Hill, New Delhi.
5. Karamcheti K., (1966), Principles of Ideal-Fluid Aerodynamics, John Wiley & Sons Inc.
6. Bertin J.J., (2002), Aerodynamics for Engineers, 4th Ed. Prentice-Hall Inc.
7. Kuethe A. M. and Chow C.-Y., (1986), Foundations of Aerodynamics, John Wiley & Sons Inc.
8. Kundu P.K. & Cohen I.M., (2008), Fluid Mechanics, Elsevier Inc.

ME010 804L02 Advanced Machining Process

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Objective: - To understand the need of smaller high quality parts and components.

Module 1 (12 hours)

Diamond turn machining (DTM):-Types of DTM - component of machine - components of DTM: spindle system, workpiece tool positioning system, machine support system, tool measurement system, machine control system – material removal mechanism in DTM – ductile regime machining – tools for DTM – tool geometries for single crystal diamond tools – tool setting – applications.

Abrasive jet micro machining (AJMM):- machining system – masking technology – erosion mechanism – metal, photo-resist and elastomer mask – erosion behavior – surface properties: hardness and roughness – pressurized power feed system – fluidized bed powder spray system – factors affecting in constant feeding – nozzle configuration – applications.

Module 2 (12 hours)

Magnetorheological nanofinishing processes: - Magnetorheological polishing fluid – rheological characteristics of fluid - Magnetorheological finishing (MRF) processes - Magnetorheological abrasive flow finishing processes (MRAFF) – performance analysis of MRAFF process - Magnetorheological jet finishing processes:- working principle, MR jet finishing machine, polishing performance.

Micro/nano finishing with flexible flow of abrasives:- process principle and description – process technology – selection of media – effect of process parameters of performance – mechanism of material removal – process capabilities - applications.

Module 3 (12 hours)

Ultrasonic micromachining (USMM):- machine tool – elements of USMM –abrasive slurry – workpiece – mechanism of material removal – process parameters: machine based parameters – performance characteristics: machining rate, surface roughness, accuracy and tool wear – effect of process parameters on quality characteristics – effect of process parameters on accuracy – process capabilities.

Module 4 (12 hours)

Electron beam micromachining: - mechanism of material removal in EB drilling – importance of vacuum – process parameters – effect of cutting speed, pulsed beam operation, heat affected zone, cross sectional area of a beam – theoretical aspects of electron beam – energy transfer to the work material – applications.

Focused Ion beam machining:- equipment – imaging with FIB system – interaction of ion with substrate – FIB milling – gas assisted FIB processing – applications.

Module 5 (12 hours)

Micro-electric discharge micromachining:-principle of micro –EDM **–** influence of pulse characteristics – high aspect ratio holes – heat affected zone.

Laser micromachining:-laser beam characteristics – laser material interaction – micromachining system – nanosecond, picoseconds, femtosecond pulse micromachining.

Text Book:

Jain V.K. Introduction to micromachining, Narosa publishers.

References

1. M. Madou, “Fundamentals of Microfabrication”
2. D. Dornfeld, S. Min and Y. Takeuchi, Recent Advances in Mechanical Micromachining, CIRP Annals - Manufacturing Technology, Volume 55, Issue 2, 2006, Pages 745-768.

ME010 804L03 Cryogenics

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart the basic concepts of Cryogenic Engineering*
- *To provide the learner with the fundamental knowledge about the properties of cryogenic materials, its storage and transfer systems*
- *To develop an understanding of various cryogenic liquefaction and refrigeration systems and their performances*

Module 1 (8 hours)

Introduction: Historical development- application of cryogenics -present areas involving cryogenic engineering-cryogenics in space technology- cryogenics in biology and medicine-superconductivity applications.

Module 2 (12 hours)

Basic thermodynamics applied to liquefaction and refrigeration process – isothermal, adiabatic and Joule Thomson expansion process -efficiency to liquefaction and coefficient of performances- irreversibility and losses. Low temperature properties of engineering materials: mechanical properties – thermal properties -electrical and magnetic properties. Properties of cryogenic fluids- superconductivity and super fluidity - materials of constructions for cryogenic applications.

Module 3 (15 hours)

Gas liquefaction systems: Production of low temperatures – general liquefaction systems-liquefaction systems for neon, hydrogen and helium.

Module 4 (15hours)

Cryogenic refrigeration systems: ideal refrigeration systems- refrigerators using liquids and gases as refrigerants- refrigerators using solids as working media - adiabatic demagnetization method.

Module 5 (10 hours)

Cryogenic storage and transfer systems: Cryogenic fluid storage vessels- cryogenic fluid transfer systems-cryo pumping.

Text Books

1. Barron R., *Cryogenic Systems*, Oxford Science Publications
2. Scott R.B., *Cryogenic Engineering*, Van Nostrand Co.

Reference Books

1. Mamata Mukhopadyay., *Fundamentals of Cryogenic Engineering*, PHI Learning
2. Haseldon G.G., *Cryogenic Fundamentals*, Academic Press
3. Flynn T.M., *Cryogenic Engineering*, Marcel Dekker.

ME010 804 L04 Acoustics and Noise Control

Teaching scheme **Credits:** 4

2 hours lecture and 2 hours tutorial per week

Objectives:

- *Elementary physical acoustics in 1D and its extension to simple 3D situations*
- *The significance of human factors in acoustics*
- *Fundamentals of architectural acoustics and noise control*

Module1 (12 hours)

Longitudinal wave propagation in a rod-Derivation of wave equation-Physical interpretation of the wave equation solution-One Dimensional Waves in a Gas-Acoustic Energy and Acoustic Intensity-Energy in a plane progressive wave-Acoustic Impedance

Module 2 (12 hours)

Sound Perception and the Decibel Scale-The ear-The decibel Scale-Combining Sound Levels in Decibels-Octave Bands-Loudness-The “A” Weighting-Legal requirements for noise control

Module 3 (12 hours)

Acoustic Resonance-Resonance of a pipe closed at both ends-Resonance of a pipe closed at one end, open at the other-Reflection & Transmission of Plane Acoustic Waves-Sound Transmission through layers and partitions-Transmission through a layer-Transmission through solid partitions

Module 4 (12 hours)

Room Acoustics-Acoustic Absorption-Reverberation Time-Sound Transmission between Rooms

The wave equation in 3 dimensions-Acoustic impedance of a spherical wave - near and far field effects-Source efficiency

Module 5 (12 hours)

Directionality of acoustic sources and receivers-Directivity index-Screens-Silencers

Helmholtz resonator design-Expansion chamber silencer design-Dissipative silencers

Active control of noise

References

1. Turner and Pretlove, Acoustics for Engineers, Macmillan, 1991
2. Kinsler, Frey, Coppens & Sanders. Fundamentals of Acoustics. 3rd Edition. John Wiley, 1982
3. Smith, Peters and Owen, Acoustics and Noise Control, Addison-Wesley-Longman, 2nd edition 1996
4. Bies and Hanson, Engineering Noise Control, theory and practice E&FN Spon, 2nd edition, 1996

ME010 804L05 Non Destructive Testing

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Module 1 (12 hours)

What is NDT,Comparison between destructive and NDT, Importance of NDT, Scope of NDT, difficulties of NDT, future progress in NDT, economics aspects of NDT.

Visual Inspection - tools, applications and limitations - Fundamentals of visual testing: vision, lighting, material attributes, environmental factors, visual perception, direct and indirect methods - mirrors, magnifiers, boroscopes, fibroscopes, closed circuit television, light sources and special lighting, a systems, computer enhanced system.

Liquid Penetrant Inspection: principles, properties required for a good penetrants and developers - Types of penetrants and developers, and advantages and limitations of various methods of LPI - **Magnetic Particle Inspection** - LPI technique/ test procedure, interpretation and evaluation of penetrant test indications, false indication, and safety precaution required in LPI, applications, advantages and limitations.

Module 2 (12 hours)

Magnetic Particle Inspection (MPI)- Principles of MPI, basic physics of magnetism, permeability, flux density, cohersiveforce, magnetizing force, rentivity, residual magnetis - Methods of magnetization, magnetization techniques such as head shot tecnique, cold shot technique, central conductor testing, magnetization using products using yokes, direct and indirect metod of magnetization, continous testing of MPI, residual tecnique of MPI, system sensitivity, checking devices in MPI, interpretation of MPI, indications, advantage and limitation of MPI - **Acoustical Holography**: Principles, types, applications, advantages and limitations.

Module 3 (12 hours)

Ultrasonic Testing (UT): principle, types of waves, frequency, velocity, wavelength, reflection, divergence, attenuation, mode conversion in ultrasonic UT testing methods - contact testing and immersion testing, normal beam and straight beam testing, angle beam testing, dual crystal probe, ultrasonic testing techniques - resonance testing, through transmission technique, pulse echo testing technique, instruments used UT, accessories such as transducers, types, frequencies, and sizes commonly used, reference blocks wit artificially created defects, calibration of equipment, applications, advantages, limitations, A, B and C scan - Time of Flight Diffraction (TOFD).

Module 4 (12 hours)

Radiography Testing (RT): Principle, electromagnetic radiation sources: X-ray source, production of X-rays, high energy X-ray source, gamma ray source - Properties of X-rays and gamma rays - Inspection techniques like SWSI, DWSI, DWDI, panoramic exposure, real time radiography, films used in industrial radiography, types of film, speed of films, qualities of film, screens used in radiography, quality of a good radiograph, film processing, interpretation,

evaluation of test results, safety aspects required in radiography, applications, advantages and limitations of RT.

Module 5 (12 hours)

Eddy Current Testing (ECT) - Principle, physics aspects of ECT like conductivity, permeability, resistivity, inductance, inductive reactance, impedance - Field factor and lift of effect, edge effect, end effect, impedance plane diagram in brief, depth of penetration of ECT, relation between frequency and depth of penetration in ECT, equipments and accessories, various application of ECT such as conductivity measurement, hardness measurement, defect detection, coating thickness measurement, advantages and limitations of eddy current testing.

Thermography: Principles, contact and non contact inspection methods - heat sensitive paints - heat sensitive papers - thermally quenched phosphors liquid crystals - techniques for applying liquid crystals - calibration and sensitivity - other temperature sensitive coatings - non contact thermographic inspection - advantages and limitation - infrared radiation and infra-red detectors, instrumentations and methods, applications.

TEXT BOOKS:

1. Baldev Raj, Practical Non – Destructive Testing, Narosa Publishing House (1997).

REFERENCE BOOKS:

1. Hull B. and V.John, Non-Destructive Testing, Macmillan (1988).
2. Krautkramer, Josef and Hebert Krautkramer, Ultrasonic Testing of Materials, Springer-Verlag.

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ME010 804 L06 Advance Operations Research

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Objectives

- *The course is designed to develop an understanding of advanced operation research and related techniques.*

Module I (12 hours)

Linear Programming: Problem Formulation, Simplex Method, Duality Theory, Dual Simplex Method, Revised Simplex Method, Sensitivity Analysis.

Module II (12 hours)

Network Techniques: Examples of Network Flow Problems, Transportation Problems Assignment Problems, Shortest Path Model, Dijkstra's Algorithm.

Module III (12 hours)

Integer Programming: Introduction, Basic Concepts and Simple Problems: Gomory's Cutting Plane Algorithm, Branch and Bound Method.

Module IV (12 hours)

Goal Programming: Introduction, Basic Concepts, Weights Method, Preemptive Method.
Dynamic Programming: Basic Concepts, Forward and Backward Computational Procedures, Application of Dynamic Programming - Stage coach problem, Cargo loading problem.

Module V (12 hours)

Simulation: Basic Concepts, Discrete and Continuous systems, Generation of Random Numbers, Monte-Carlo Simulation, Simulation software.

Text Books

1. Verma A.P., *Operation Research,* S. K. Kataria & Sons.
2. Pannerselvam R., *Operation Research*, Prentice–Hall of India.

Reference Books

1. Hamdy A Taha, *Operations Research, – An Introduction,* Pearson Education.
2. Ravindran A., *Operations Research – Principles and Practice,* Wiley India (P) Ltd.
3. Srinivasan G., *Operations Research- Principles and Applications,* Prentice–Hall of India.
4. Hillier & Lieberman, *Introduction to Operations Research-Concepts and Cases,* Tata Mcgraw Hill.

Electives IV

ME010 805G01 Industrial Safety

Teaching scheme **Credits:** 4

2 hours lecture and 2 hours tutorial per week

Objectives

- *To develop an understanding of the principles of safety,terminolgies in accident prevention and its theories..*
- *To understand the theory and practice of occupational health,ergonomics and hygiene,principle of fire engineering and fire fighting.*

Module-I (12 Hours)

Development of safety movement: - Need for safety-safety and productivity-planning for safety-planning procedure-safety policy-formulation of safety policy-safety budget-role and qualification of safety professional-safety committees-need, types and functions of committees-safety organizations.

Module II (12 Hours)

Accident prevention: - Basic philosophy of accident prevention-nature and causes of accidents-accident proneness-cost of accidents-accident prevention methods-Domino theory-safety education and training-training methods-motivation and communicating safety-personal protective equipments.

Module III (12 Hours)

Safety management techniques: - Safety inspection-Safety sampling technique-Safety audit-Safety survey-Incident recall technique-Job safety analysis-Damage control-Risk management.
*Involvement in safety***: -** Role of management-role of supervisors-role of workmen- role of unions-role of government

Module IV (12 Hours)

Occupational health and hygiene: - Functional units and activities of occupational health and hygiene-types of industrial hazards-physical, chemical, mechanical, electrical, social, biological, ergonomic and environmental hazards-factors impeding safety-house keeping-hearing conservation programme

Module V (12 Hours)

*Industrial fire protection***: -** Fire chemistry-classification of fires-fire prevention activities-fire risks-fire load -contributing factors to industrial fires-fire detection-industrial fire protection systems.

Text Books:-

1. Heinrich H.W, 'Industrial accident prevention', McGraw Hill Company, New York, 1980.

2. Frank P Lees, 'Loss prevention in process industries', Vol I, II, III, Butterworth, London, 1980.
3. R.P.Blake, "Industrial Safety", Prentice Hall of India, New Delhi

Reference books:-

1. "Accident prevention manual for Industrial Operations", National Safety Council, Chicago, 1989.
2. Brown D.B, "System Analysis and Design for safety", Prentice Hall, New Jercy.

ME010 805G02 Disaster Management

Teaching scheme **Credits:** 4

2 hours lecture and 2 hours tutorial per week

MODULE 1 (12 hours)

Importance of disaster management - Types of emergencies – major industrial disasters – Components of a major hazard control system – identification of major hazard control installations – purpose and procedures – safe operation of major hazard installations – mitigation of consequences – reporting to authorities. Implementation of major hazard control systems – group of experts – training – checklists – inspection – evaluation of major hazards – information to the public – manpower requirements – sources of Information

MODULE 2 (12 hours)

Emergency planning – On-site emergency planning – formulation of the plan and emergency services – Identification of resources – actions and duties – emergency procedure – mock drills. Off-site emergency planning – objectives and elements of off-site plan – role of administrative machinery – role of major hazard works management – role of the local authority. Emergency preparedness at local level – Awareness and preparedness for emergencies at local level (APELL) – The process and its partners.

MODULE 3 (12 hours)

Requirements of emergency plan as per Indian legislations like Factories Act, Manufacture, Storage and Import of Hazardous Chemicals Rules, Chemical Accidents (Emergency planning, Preparedness and Response) Rules-Applications of remote sensing and GIS in disaster management

MODULE 4 (12 hours)

Emergency planning and preparedness in international standards like ISO 14001, OHSAS 18001 and OSHA's Process Safety Management System, Emergency Planning in Seveso II directive – elements of emergency planning in IS : 18001 – Hazardous Materials / Spills Emergencies – contingency plans for road transportation of hazardous chemicals – contingency plans for oil spills in marine environment.

MODULE 5 (12 hours)

Natural Hazards – potentially hazardous natural phenomena – earthquakes – landslides – flooding – cyclones – hazards in arid and semi-arid areas – nature of the hazard – hazard management activities – disaster mitigation – natural hazard prediction – emergency preparedness – disaster, rescue and relief – post disaster rehabilitation and reconstruction – education and training activities – vulnerable elements to be considered in the development planning for natural hazard management .

TEXT BOOKS:

1. Petak, W.J and Atkisson, A.A.: *Natural Hazard Risk Assessment and Public Policy: Anticipating the Unexpected*

2. Frank P Lees, '*Loss prevention in process industries'*, Vol I, II, III, Butterworth, London, 1980

REFERENCES:

1. ILO, Geneva: *Major Hazard Control – a Practical Manual.*
2. UNEP, Paris : *APELL - A Process for responding to technological accidents , A Handbook,* Industry & Environment Office., 1998
3. *Accident Prevention Manual for Business and Industry, Vol. I* – National Safety Council, USA.
4. *Oil spill Response : The National Contingency Plan* - Institute of Petroleum, London
5. U.R. Rao : *Space Technology for Sustainable Development*

ME010 805G03 Nano Technology

Teaching scheme **Credits:** 4

2 hours lecture and 2 hours tutorial per week

MODULE 1 (12 hours)

Introduction to nano technology – definition – why nano – application in different fields - nano materials, solid state devices – carbon nano tubes: - structure, sythesis, growth mechanisms, properties, carbon nano tubes based nano objects, applications.

MODULE 2 (12 hours)

Nano tribology characterization studies – friction and wear on the atomic scale – nano mechanical properties of solid surface and thin films.

MODULE 3 (12 hours)

Mechanical properties of nano structures: - experimental techniques, indentation and scratch tests, bending tests; experimental results and discussion – nano tribology of ultra thin and hard amorphous carbon films.

MODULE 4 (12 hours)

Nano boundary lubrication – kinetics and energetic in nano lubrication - Nano tribology for data storage application

MODULE 5 (12 hours)

Industrial applications: - micro actuators for dual storage servo systems – MEMS/NEMS materials and applications – mechanical properties of micro machined structures.

TEXT BOOKS:

1. Bhushan – Springer Handbook of Nano technology.

REFERENCE BOOKS:

1. Nano manufacturing Handbook Busnaina CRC press.
2. Pradeep T., IIT Madras - NANO: The Essentials, Tata McGraw Hill

ME010 805 G04 Finite Element Analysis

Teaching scheme **Credits:** 4

2 hours lecture and 2 hours tutorial per week

Objectives

- *To learn the mathematical background of finite element analysis*
- *To solve structural mechanics problems using finite element approach*

Module I (12 hours)

Introduction to FEA:- Brief History, Applications of FEA in various fields, Advantages and disadvantages of FEA.

Review of Theory of Elasticity: - Degrees of freedom, rigid body motion, principle of minimum potential energy, stress and strain at a point, principal stresses, Von-Mises stress.

Basic equations of elasticity: - Stress-strain and, strain displacement relationships, 2D and 3D cases.

Basic steps in finite element problem formulation, importance of discretization, different types of elements, shape functions and stiffness matrices of 1D bar and beam elements.

Module II (12 hours)

Assembly of elements and matrices:- Concept of element assembly, 1D bar element assembly, boundary conditions, 1D problems. Analogous (1-D) problems of torsion and heat conduction.

Co-ordinate systems: - Global and local co-ordinate systems, transformation matrix

Module III (12 hours)

Structural analysis: - Plane truss problems, beam problems

2D finite element formulations: - Three nodded triangular element, four nodded rectangular element, compatibility, four nodded quadrilateral element, eight nodded quadrilateral element.

Variational methods : - Functionals - weak and strong form - essential and non- essential boundary conditions - Principle of stationary potential energy - Rayleigh-Ritz method -simple examples.

Module IV (12 hours)

Higher order Elements:- Quadratic and cubic elements, shape functions, Pascal's triangle, Pascal's pyramid, convergence criterion, Constant Strain triangle element and Linear Strain triangle element- stiffness matrices. Isoparametric elements, natural co-ordinates, area co-ordinates, linear triangle and quadratic triangle elements, Quadrilateral elements.

Module V (12 hours)

Modal analysis: - Eigen vectors and Eigen values, Consistent and lumped mass matrices. Mass matrices for bar element, truss element, beam element, frame element.

Finite element formulation of free vibration problems:- Natural frequencies and mode shapes of longitudinal vibration of bar element, flexural vibrations of beam element.

Structure of a FEA software package: - Pre-processor-solver-Post-processor.

Text Books

1. Hutton David V “Fundamentals of Finite Element Analysis”, TMH 2005
2. Daryl L.Logan, “A first course in the Finite Element Method”, Cengage Learning, Fourth edition, 2007.
3. Robert D.Cook, “Concepts and applications of Finite Element Analysis”, Wiley India, Fourth Edition, 2003.

Reference Books

1. Reddy J.N. “An Introduction to Finite Element Method”, McGraw-Hill, 2000.
2. Krishnamurthy, C.S., “Finite Element Analysis”, Tata McGraw-Hill, 2000.
3. Seshu P “A text book of Finite Element Analysis” PHI,2005

ME010 805 G05 Optimization Methods in Design

Teaching scheme **Credits:** 4

2 hours lecture and 2 hours tutorial per week

Module 1 (12 hours)

Nonlinear optimization: Introduction - one-dimensional optimization - elimination methods - unrestricted search, exhaustive scare Fibonacci and Golden section methods - Interpolation methods - quadratic and cubic interpolations, direct root methods.

Module 2 (12 hours)

Unconstrained nonlinear optimization: Direct search methods - random search methods - pattern search methods – method of rotating coordinates - descent methods - steepest descent, conjugate gradient, Quasi-Newton, and variable metric methods.

Module 3 (12 hours)

Constrained nonlinear optimization: Direct methods - the complex method, cutting plane method, methods of feasible directions - indirect methods - transformation techniques, interior and exterior penalty function methods.

Module 4 (12 hours)

Non-traditional optimization: Introduction to genetic algorithms, simulated annealing, particle swam optimization and ant colony optimization.

Module 5 (12 hours)

Static Applications: - Structural applications – Design of simple truss members - Design applications – Design of simple axial, transverse loaded members for minimum cost, weight – Design of shafts and torsionally loaded members – Design of springs.
Dynamic Applications:-Dynamic Applications – Optimum design of single, two degree of freedom systems.
Application in Mechanisms – Optimum design of simple linkage mechanisms.

Text Books

1 Singiresu S. Rao, *Engineering optimization: theory and practice,* 3rd Edition, Wiley Interscience, 1996
2. Kalyanmoy Deb, *Optimization for engineering design*, PHI, New Delhi, 2000
3. David E. Goldberg, *Genetic algorithms in search, optimization and machine learning,* Addison Wesley Pub. Co., 1989
4. Harvey M. Salkin, *Integer programming,* Addison-Wesley Pub. Co., 1975
5. Stephen C. Nash and Ariela Sofer, *Linear and nonlinear programming,* McGraw Hill College Div., 1995

Reference Books

1. Fred Glover, Manuel Laguna, and Fred Laguna, *Tabu search,* Kluwer Academic Publishers, 1997
2. Johnson Ray, C., “Optimum design of mechanical elements”, Wiley, John & Sons, 1990.
3. Goldberg, D.E., “Genetic algorithms in search, optimization and machine”, Barnen, Addison-Wesley, New York, 1989.

ME010 805 G06 Petrochemical Engineering

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Objectives

• *To impart the basic concepts of science of petroleum drilling and transportation of oil.*

EXPLORATION AND DRILLING

Module 1 (12 Hours)

Methods of petroleum prospecting and exploration such as geophysical, seismic, etc. - drilling equipments such as rigs, platforms etc - techniques for offshore and onshore operation.

Directional Drilling: Objectives, Types of deflection tools, tool orientation, Directional well profiles, Well path deflection & correction.

Down Hole Motors: Positive displacement motors and Turbo-drills, motor description, Power calculation and applications - Auto-track and verti-track system - Rotary Steerable motors, Geo-steering tools.

Horizontal Well Drilling: Horizontal well objectives and selection, Different profiles, drilling techniques, Mud requirements & characteristics, casing and drill string requirements and completion programs. Problems.

Module 2 (12 Hours)

Slant Hole Drilling: Objectives and selections, Well profiles and applications.

Down the Hole Well Surveying: Well surveying objectives, surveying methods, Surveying Analysis methods and calculations for well coordinates.

Measurements While Drilling: Objectives of MWD/ LWD, MWD tools, Telemetry system and data interpretation.

Directional Drilling Problems and Their Remedies.

Special Methods of Drilling : Aerated drilling, Under-balanced drilling, Overbalanced drilling, HPHT Drilling, Variable pressure regime, Plasma drilling, Electrical Drilling, Top drive drilling, Re-entry drilling, Jet Drilling, Extended reach drilling, Multilateral drilling, Slim hole drilling, coil tubing drilling. Problems.

Drilling economics. Computer Application in Drilling.

DESIGN AND CONSTRUCTION OF PIPELINE

Module 3 (12 Hours)

Objective and scope of pipeline as a means of fluid transportation with special reference to crude oil/gas/refined products, Economics of Pipeline transportation.

Design of Pipeline: Factors influencing oil, gas and refined products as pipeline design; Hydraulic surge and water hammer; specific heat of liquids; river crossing; pipe size and station spacing etc.

Theory and different formulae of the flow of fluids in oil/gas pipelines; basic equations for the flow of fluids through pipes; different flow equations for laminar and turbulent flow of compressible and incompressible fluids (Newtonian); Introduction to the flow of Non-Newtonian fluids through pipes; multiphase flow and loop pipelines.

Module 4 (12 Hours)
Construction of pipelines; materials; project specifications; general equipment specifications (Pipes, valves and fittings); Installation of expansion loops and thermodymetric tapping plant. Pigging, Pigging Technology: pig launcher and receiver, intelligent pigging, types of pigs - Corrosion protection and control; Design of cathodic protection system, Pipeline automation. Problems.

Module 5 (12 Hours)
Offshore Pipeline: Design and control of Sag and Over bend; Description of stinger; and Riser, articulated stinger, construction of offshore pipeline, Method of underwater welding.
Hydrates, wax & scale - formation and prevention. Crude conditioning and use of additives to improve flow conditions. City distribution network of oil/gas. Lease and custody transfer.

References:

1. Berger B D, Anderson K E, “Modern Petroleum” Pennwell books
2. Bradley H B, “Petroleum Engineering Handbook”, SPE
3. Cole F W, Reservoir Engineering manual
4. Carl Gatlin, “Petroleum Engineering Drilling and Well Completions” Prentice Hall .
5. Mc Cray and Cole, “Oil Well Drilling Technology” Oklahoma Press

ME010 806 Mechanical Systems Laboratory

List of experiments

1. Test on reciprocating air compressor
2. Tests on blowers and rotary compressors
3. Free vibration analysis
4. Forced vibration analysis
5. Balancing of reciprocating and revolving masses
6. Assembling of mechanical systems
7. Test on refrigeration equipment
8. Test on air conditioning unit
9. Determination of thermal conductivity of conducting and insulating materials
10. Determination of emissivity of surfaces
11. Heat flow through lagged pipes
12. Heat flow through composite walls
13. Determination of overall heat transfer coefficient of heat exchangers
14. Free convection
15. Forced convection
16. Stefan-Boltzmann apparatus
17. Universal governor apparatus
18. Whirling of shafts
19. Gyroscope
20. Friction in hydrodynamic bearings
21. Heat pipe
22. Vortex tube
23. Critical heat flux

ME010 807 Project Work

Teaching scheme **credits: 4**

6 hours practical per week

The progress in the project work is to be presented by the middle of eighth semester before the evaluation committee. By this time, the students will be in a position to publish a paper in international/ national journals/conferences. The EC can accept, accept with modification, and request a resubmission.

The progress of project work is found unsatisfactory by the EC during the middle of the eighth semester presentation, such students has to present again to the EC at the end of the semester and if it is also found unsatisfactory an extension of the project work can be given to the students.

Project report: To be prepared in proper format decided by the concerned department. The report shall record all aspects of the work, highlighting all the problems faced and the approach/method employed to solve such problems. Members of a project group shall prepare and submit **separate** reports. Report of each member shall give details of the work carried out by him/her, and only summarise other members' work.

The student's sessional marks for project will be out of 100, in which 60 marks will be based on day to day performance assessed by the guide. Balance 40 marks will be awarded based on the presentation of the project by the students before an evaluation committee.

For Project, the minimum for a pass shall be 50% of the total marks assigned to the Project work.

ME010 808 Viva -Voce

Teaching scheme **credits: 2**

A comprehensive oral Viva-voce examination will be conducted to assess the student's intellectual achievement, depth of understanding in the specified field of engineering and papers published / accepted for publication etc. At the time of viva-voce, certified bound reports of seminar and project work are to be presented for evaluation. The certified bound report(s) of educational tour/industrial training/ industrial visit shall also be brought during the final Viva-Voce.

An internal and external examiner is appointed by the University for the Conduct of viva voce University examination.

For Viva-voce, the minimum for a pass shall be 50% of the total marks assigned to the Viva-voce.

Note: If a candidate has passed all examinations of B.Tech. course (at the time of publication of results of eighth semester) except Viva-Voce in the eighth semester, a re-examination for the Viva-Voce should be conducted within one month after the publication of results. Each candidate should apply for this 'Save a Semester examination' within one week after the publication of eighth semester results.