Production Engineering (PE)

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.

Text books:-

1. Erwin Kreyszing – Advance Engg. Mathematics – Wiley Eastern Ltd.
2. B.S. Grewal – Higher Engg. Mathematics - Khanna Publishers

Reference

1. B.V. Ramana - Higher Engg. Mathematics – McGraw Hill
2. K Venkataraman- Numerical methods in science and Engg -National publishing co
3. S.S Sastry - Introductory methods of Numerical Analysis -PHI
4. T.Veerarajan and T.Ramachandran- Numerical Methods- McGraw Hill

3. Babu Ram – Engg. Mathematics -Pearson.
4. H.C.Taneja Advanced Engg. Mathematics Vol I – I.K.International

University Examination Pattern

PART A: Short answer questions (one/two sentences)	***5 x 3 marks=15 marks***
All questions are compulsory. There should be at least one question from each module.	
PART B: Analytical/Problem solving questions	***5 x 5 marks=25 marks***
All questions are compulsory. There should be at least one question from each module.	
PART C: Descriptive/Analytical/Problem solving questions	***5 x 12 marks=60 marks***
Two questions from each module with choice to answer one question	

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

PE010 303: Fluid Mechanics

(Common with AN010 303 & ME010 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

University Examination Pattern

PART A:	***Short answer questions (one/two sentences)*** All questions are compulsory. There should be at least one question from each module.	***5 x 3 marks=15 marks***
PART B:	***Analytical/Problem solving questions*** All questions are compulsory. There should be at least one question from each module.	***5 x 5 marks=25 marks***
PART C:	***Descriptive/Analytical/Problem solving questions*** Two questions from each module with choice to answer one question.	***5 x 12 marks=60 marks***

Maximum Total Marks: 100

PE010 304: Metallurgy and Material Science

(Common with ME 010 304 and AU010 304(ME))

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. Avner -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.

University Examination Pattern

PART A:	***Short answer questions (one/two sentences)*** All questions are compulsory. There should be at least one question from each module.	***5 x 3 marks=15 marks***
PART B:	***Analytical/Problem solving questions*** All questions are compulsory. There should be at least one question from each module.	***5 x 5 marks=25 marks***
PART C:	***Descriptive/Analytical/Problem solving questions*** Two questions from each module with choice to answer one question.	***5 x 12 marks=60 marks***

Maximum Total Marks: 100

PE010 305: Programming in C

(Common with ME010 305(ME) and AU010 305(ME))

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*

University Examination Pattern

PART A:	***Short answer questions (one/two sentences)*** All questions are compulsory. There should be at least one question from each module.	***5 x 3 marks=15 marks***
PART B:	***Analytical/Problem solving questions*** All questions are compulsory. There should be at least one question from each module.	***5 x 5 marks=25 marks***
PART C:	***Descriptive/Analytical/Problem solving questions*** Two questions from each module with choice to answer one question.	***5 x 12 marks=60 marks***

Maximum Total Marks: 100

PE010 306(CE) Strength of Materials & Structural Engineering

(Common with ME010 306(CE), PO010 306(CE) and AU010 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.

University Examination Pattern

PART A:	***Short answer questions (one/two sentences)*** All questions are compulsory. There should be at least one question from each module.	***5 x 3 marks=15 marks***
PART B:	***Analytical/Problem solving questions*** All questions are compulsory. There should be at least one question from each module.	***5 x 5 marks=25 marks***
PART C:	***Descriptive/Analytical/Problem solving questions*** Two questions from each module with choice to answer one question.	***5 x 12 marks=60 marks***

Maximum Total Marks: 100

PE010 307 STRENGTH OF MATERIALS LABORATORY

(Common with ME010 408 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.

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

PE010 308: Fluid Mechanics Laboratory

(Common with ME010 308, AN010 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 2π 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

Text books:-

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.

References

1. I.N. Sneddon – Elements of partial differential equations – Mc Graw Hill
2. B.V. Ramana – Higher Engg. Mathematics – Mc Graw Hill
3. Richard A Johnson – Miller Fread's probability & Statistics for Engineers- Pearson/ PHI

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

University Examination Pattern

PART A: ***Short answer questions (one/two sentences)*** ***5 x 3 marks=15 marks***
All questions are compulsory. There should be at least one question from each module.

PART B: ***Analytical/Problem solving questions*** ***5 x 5 marks=25 marks***
All questions are compulsory. There should be at least one question from each module.

PART C: ***Descriptive/Analytical/Problem solving questions*** ***5 x 12 marks=60 marks***
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

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.

University Examination Pattern

PART A:	***Short answer questions (one/two sentences)*** All questions are compulsory. There should be at least one question from each module.	***5 x 3 marks=15 marks***
PART B:	***Analytical/Problem solving questions*** All questions are compulsory. There should be at least one question from each module.	***5 x 5 marks=25 marks***
PART C:	***Descriptive/Analytical/Problem solving questions*** Two questions from each module with choice to answer one question.	***5 x 12 marks=60 marks***

Maximum Total Marks: 100

PE010 403: Hydraulic Machines

(Common with ME010 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*, Wiley & 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

University Examination Pattern

PART A: ***Short answer questions (one/two sentences)*** ***5 x 3 marks=15 marks***
All questions are compulsory. There should be at least one question from each module.

PART B: ***Analytical/Problem solving questions*** ***5 x 5 marks=25 marks***
All questions are compulsory. There should be at least one question from each module.

PART C: ***Descriptive/Analytical/Problem solving questions 5 x 12 marks=60 marks***

Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

PE010 404: Manufacturing Process

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

Objectives

- *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.*
- *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.*
- *The course will also provide methods of analysis allowing a mathematical/physical description of forming processes.*

Module 1 (12 hours)

Patterns: Different types of patterns – colour codes of patterns.
Moulding sands: Natural and synthetic sand- ingredients of moulding sands- special sand additives sand mixing- general properties of moulding sand – testing of moulding sand - effect of ingredients and Additives on properties of moulding sand- reusability of moulding sands- sand conditioning.
Core and core making: Purpose of cores - core prints – types of cores – core sand ingredients – requirements of core sand- core sand mixing – binding materials – core boxes, core making, baking, coating, reinforcing and venting.

Module 2 (12 hours)

Risering:- reasons for risering – riser size and location on directional solidification – methods for controlling solidification:- insulation, exothermic sleeves and riser components, chills, chaplets, padding, - riser shape, size, and contact area, location of risers – theoretical consideration of risering:- Caine's and modulus method, riser size and solidification- riser treatment –riser feeding distance-risering of alloys.

Gating System: The fluid flow, Bernoulli's theorem, turbulent and streamline flow - top, parting line, bottom and step gates – gating design considerations:- pouring cups, basins, streamlined gating - details of gating ratio – eliminating slag and dross – theoretical aspects of gating:- turbulence, velocity calculations in real gating, tapered sprue.

Module 3 (12 hours)

Ferrous foundry metallurgy: Gray cast iron – composition – effect of composition in properties – types of graphite in gray cast iron – foundry characteristics of grey cast iron – effect of inoculation and inoculants – low alloy and high alloy cast iron – malleable iron – white heart and black heart malleable iron – malleablisation – S.G. iron – composition and properties.

Module 4 (12 hours)

Non-ferrous foundry metallurgy: Foundry characteristics of copper and aluminium base alloys – degassing and melt treatment. Melting and pouring: Types of furnaces used for C.I., steel and non-ferrous metals – details and charge calculation in cupola charging

Module 5 (12 hours)

Cleaning and inspection: Knock out and fettling – destructive and non-destructive testing- salvaging.

Mechanisation in foundry: Elementary ideas of mechanisation in sand conditioning and supply, moulding, core making, knock out and fettling.

Text books:-

1. Principles of Metal Casting - Hine and Rosenthal
2. Manufacturing Engineering and Technology - Kalapakjian and Schmid

References

1. Foundry Technology - P.R.Beeley
2. Manufacturing Science - Amitabha Ghosh and Ashok Kumar Mallick

University Examination Pattern

PART A:	***Short answer questions (one/two sentences)*** All questions are compulsory. There should be at least one question from each module.	***5 x 3 marks=15 marks***
PART B:	***Analytical/Problem solving questions*** All questions are compulsory. There should be at least one question from each module.	***5 x 5 marks=25 marks***
PART C:	***Descriptive/Analytical/Problem solving questions*** Two questions from each module with choice to answer one question.	***5 x 12 marks=60 marks***

Maximum Total Marks: 100

PE010 405: Machine Drawing

(Common with ME010 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 following Valves - -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

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PE010 406(EE) Electrical Technology

(Common with ME010 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

University Examination Pattern

PART A:	***Short answer questions (one/two sentences)***	***5 x 3 marks=15 marks***
	All questions are compulsory. There should be at least one question from each module.	
PART B:	***Analytical/Problem solving questions***	***5 x 5 marks=25 marks***
	All questions are compulsory. There should be at least one question from each module.	
PART C:	***Descriptive/Analytical/Problem solving questions***	***5 x 12 marks=60 marks***
	Two questions from each module with choice to answer one question.	

Maximum Total

PE010 407: Hydraulic Machines Laboratory

(Common with ME010 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

PE010 408: Computer Programming Laboratory

(Common with ME010 307 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

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)

Text books:-

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

References

1. S.Bathul – text book of Engg.Mathematics – Special functions and complex variables –PHI
2. B.S. Grewal – Numerical methods in Engg. and science - Khanna Publishers

3. Dr.M.K Venkataraman- Numerical methods in science and Engg -National publishing co
4. S.S Sastry - Introductory methods of Numerical Analysis -PHI
5. P.K.Gupta and D.S. Hira – Operations Research – S.Chand
6. Panneer Selvam– Operations Research – PHI
7. H.C.Taneja – Advanced Engg. Mathematics Vol II – I.K.International

PART	University Examination Question Paper Pattern	MARKS
A	***Short answer questions (one/two sentences)*** All questions are compulsory. There should be at least one question from each module	***5 x 3 = 15***
B	***Analytical/Problem solving questions*** All questions are compulsory. There should be at least one question from each module	***5 x 5 = 25***
C	***Descriptive/Analytical/Problem solving questions*** Two questions from each module with choice to answer one question	***5 x 12 = 60***
	Maximum Total Marks	100

PE 010 502 Theory of Metal Cutting

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

Objectives:

- *To introduce developments in metal cutting theory and different processes.*
- *To analyze the mechanics of cutting, economy in cutting etc.*

MODULE 1 (12 hours)

Introduction to metal removal process – types of machine tools, Lathes: Engine Lathes – specification-general study of main parts and tool and work holding devices, lathe operations and cutting tools used, speed and feed for turning, turning time calculations. Typesof lathes - Capstan, Turret, Copying. Automatic and semi-automatic lathes - their working principles, applications and essential difference from engine lathe.

MODULE 2 (12 hours)

Theory of metal cutting: Historical back ground –Classification of manufacturing process – Deformation of metals, shearing etc (review only) – Performance & process parameters - Oblique & orthogonal cutting – Mechanism of chip formation, types of chip – Tool geometry systems – Mechanism of orthogonal cutting: Thin and thick zone model, Merchant's analysis, – Friction process in metal cutting: nature of sliding friction, adhesion theory, ploughing, sub layer flow – Effect of rake angle, cutting angle, nose radius etc. on cutting force and surface finish – Empirical determination of force component.

MODULE 3 (12 hours)

Thermal aspects of machining: Source of heat; temperature distribution in chip, shear plane & work piece - effect of speed, feed & depth of cut etc on cutting force and surface roughness – different tool materials, HSS, WC, coated WC, Alumina, cBN, diamond etc. - Cutting fluids, classification and applications of fluids – Tool wear and tool life – Tool wear mechanisms- Taylor's equation and wear land; rapid, steady and catatospheric wear – Economics of machining – Machineability index.

MODULE 4(12 hours)

Grinding: - cylindrical, centerless, internal, surface grinding machines. Grinding wheels: - types of abrasives – grain size – type of bonds – grade – structure – marking system – fluids –truing and dressing – evaluation of grinding wheel performance – grinding principle – grinding forces.

MODULE 5 (12 hours)

Milling:- column and knee type, bed type milling machines – different methods of milling – conventional and climb milling – nomenclature of milling cutters – cutting forces in milling– attachments and accessories for milling process.

Text Books:-

1. Armarego & Brown, The Machining of Metals, Prentice - Hall

2. HMT, Production Technology, Tata McGraw Hill
3. Kalpakjian, Manufacturing Engineering & Technology, Addison – Wesley, 4nd edn.
4. Paul. H. Black, Theory of Metal Cutting, McGraw Hill

REFERENCES

1. Metcut research, Machinablity Data Center Vol.1 & 2, Metcut research associates, Cincinnati
2. Lal G.K., Introduction to Machining Science, New Age publishers
3. Shaw Milton C. Metal cutting principles, Oxford.
4. Malkin S. Grinding Technology, Ellis horwood.
5. Boothroyd G. Fundamentals of machining and machine tools, Marcel Dekker.
6. Trent E.M. Metal cutting, Buttorworth.

PART	University Examination Question Paper Pattern	MARKS
A	***Short answer questions (one/two sentences)*** All questions are compulsory. There should be at least one question from each module	***5 x 3 = 15***
B	***Analytical/Problem solving questions*** All questions are compulsory. There should be at least one question from each module	***5 x 5 = 25***
C	***Descriptive/Analytical/Problem solving questions*** Two questions from each module with choice to answer one question	***5 x 12 = 60***
	Maximum Total Marks	100

PE010 503: Advanced Mechanics of Materials

(Common with ME010 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

PART	University Examination Question Paper Pattern	MARKS
A	***Short answer questions (one/two sentences)*** All questions are compulsory. There should be at least one question from each module	***5 x 3 = 15***
B	***Analytical/Problem solving questions*** All questions are compulsory. There should be at least one question from each module	***5 x 5 = 25***
C	***Descriptive/Analytical/Problem solving questions*** Two questions from each module with choice to answer one question	***5 x 12 = 60***
	Maximum Total Marks	100

PE 010 504 Industrial Engineering

Teaching scheme **Credits:** 4
3 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

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

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

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

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

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 Organisation and Engineering Economics*, Khanna Publishers.

Reference Books

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

PART	University Examination Question Paper Pattern	MARKS
A	***Short answer questions (one/two sentences)*** All questions are compulsory. There should be at least one question from each module	***5 x 3 = 15***
B	***Analytical/Problem solving questions*** All questions are compulsory. There should be at least one question from each module	***5 x 5 = 25***
C	***Descriptive/Analytical/Problem solving questions*** Two questions from each module with choice to answer one question	***5 x 12 = 60***
	Maximum Total Marks	100

PE 010 505 Metrology &Instrumentation

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

Objectives:

- *To study the concepts about measurements and instrumentation which are essential to measure and evaluate systems.*
- *To understand the relevant concepts and equipments used for selecting the measuring instruments and instrumentation procedures.*

MODULE 1 (12 hours)

Metrological concepts - Abbe principle – need for high precision measurements – problems associated with high precision measurements.Standards for length measurement – shop floor standards and their calibration – light interference – method of coincidence – slip gauge calibration – measurement errors. Comparator: - Mechanical, Optical, Pneumatic, Electrical and Electronic comparators. Optical Measuring Instruments: - Principle of Interferometry – Optical flat, principle– Interferometers – angle dekkor Autocollimators, Tool makers- Microscope.

MODULE 2 (12 hours)

Various tolerances and specifications, gauging principles selective assembly, comparators. Angular measurements – principles and instruments. Thread measurements. Surface and form metrology – flatness, roughness, waviness, roundness, cylindrically etc. Computer aided metrology – Principles and interfacing software metrology.

MODULE 3 (12 hours)

Transducers: - Classification- Static and Dynamic characteristics of Transducers and Dynamometers. Stress- Strain Measurement: Types of strain gauges- Strain measurements by using resistance strain gauges and Mechanical strain gauges-types, application. Basic concept in static and dynamic measurements: Analysis of Experimental errors Gaussian and normal error Distribution- methods of Least Squares- Simple problems.

MODULE 4 (12 hours)

Laser metrology – application of leasers in precision measurements – laser interferometer, speckle measurements, laser scanners. Co-ordinate measuring machine – types of CMM – probes used – application – non-contact CMM using Electro optical sensors for dimensional metrology – non contact sensors for surface roughness measurements.

MODULE 5 (12 hours)

Image processing and its application in metrology. And Automated machine vision applied to assembly and inspection tasks traditionally performed by human operators.

Text books:-

1. Hume - Metrology, McDonald
2. Sharpe - Metrology, ELBS

Reference*:* -

1. ASME - Hand book of industrial Metrology
2. Taher - Metrology, ELBS

3. Ted Busch - Fundamentals of Dimensional Metrology, 3rd Edition, Delmar Publishers
4. Collet C.V. and Hope A.D., Engineering Measurements, Second Edition, ELBS Longman.

PART	University Examination Question Paper Pattern	MARKS
A	***Short answer questions (one/two sentences)*** All questions are compulsory. There should be at least one question from each module	***5 x 3 = 15***
B	***Analytical/Problem solving questions*** All questions are compulsory. There should be at least one question from each module	***5 x 5 = 25***
C	***Descriptive/Analytical/Problem solving questions*** Two questions from each module with choice to answer one question	***5 x 12 = 60***
	Maximum Total Marks	100

PE010 506 Thermodynamics

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)*

OBJECTIVES:- To learn about thermodynamic systems and boundaries, study the basic laws of thermodynamics, understand various forms of energy including heat transfer and work, identify various type of properties, use tables, equations, and charts, in evaluation of thermodynamic properties, apply conservation of mass, first law, and second law in thermodynamic analysis of systems, enhance their problem solving skills and fundamentals of heat transfer with its concepts in the operation of internal combustion engines.

MODULE 1

Fundamental concepts-Scope and limitations of thermodynamics- Thermodynamic systems – different types of systems-macroscopic and microscopic analysis-continuum-Properties-State-Processes- -Thermodynamic equilibrium-Equation of state of an ideal gas-PVT system-Real gas-Real gas relations-Compressibility factor-Law of corresponding states.

MODULE 2

Laws of thermodynamics-Zeroth law of thermodynamics-Thermal equilibrium-Concept of temperature –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 equation- Joule Thompson effect.

MODULE 3

Second law of thermodynamics-Various statements and their equivalence-Reversible process and reversible cycles – Carnot cycle-Corollaries of the second law-Thermo dynamic temperature scale- Clausius inequality-Concept of entropy-Calculation of change in entropy in various thermodynamic processes-Reversibility and irreversibility-Available and unavailable energy – Third law of thermo dynamics.

Internal Combustion Engines

MODULE 4

Working of two stroke and four stroke - Petrol and Diesel Engines (Review Only). Combustion in S. I. Engine- Ignition limits - stages of combustion - combustion quality - Ignition lag - Flame propagation - Abnormal combustion - detonation - effects - Theory, chemistry and control - flash point, fire point and viscosity index.

MODULE 5

Combustion in C. I. Engines - Air Fuel ratio in C. I. Engines - Ignition Lag - diesel knock - Controlling Methods - Various stages of combustion - vaporization of fuel droplets and spray formation - Air motion - Swirl - combustion chamber - Engine

operating characteristics - Testing of I. C. Engines - Indicated power - Brake power - Volumetric Efficiency - Heat balance Test - Morse Test.

Text Books

1. Internal Combustion Engine Fundamentals	-	John B. Heywood
2. Internal Combustion Engine and Air Pollution	-	Obert E. F.
3. Heat and Thermodynamics	-	M.N.Zemansky

Reference Books

1. Internal Combustion Engine	-	Lichty L. C.
2. Internal Combustion Engine	-	V. Genesan
3. A course in internal combustion Engine	-	V. Genesan
4. Engineering Thermodynamics	-	P.K.Nag
5. Engineering Thermodynamics	-	M.Achuthan
6. Thermodynamics	-	Keenan
7. Thermodynamics	-	Obert
8. Thermodynamics	-	Holman

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B	***Analytical/Problem solving questions*** All questions are compulsory. There should be at least one question from each module	***5 x 5 = 25***
C	***Descriptive/Analytical/Problem solving questions*** Two questions from each module with choice to answer one question	***5 x 12 = 60***
	Maximum Total Marks	100

PE010 507: Thermal Engineering Laboratory

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

Objectives:

- *To understand the working of various IC engines.*
- *To get a hand on experiences on various parts of different engines*

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 turbines – exhaust gas analysis.

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 value of fuel.

Reference Books

1. John B Heywood, Internal Combustion Engine Fundamentals, Mc Graw Hill Publishing Company Sigapur,1998.
2. Obert E F,Internal Combustion Engine and air Pollution Mc Graw Hill book company New York.
3. Mathur and Sharma,A course in Internal Combustion Engine - Dhanpat Rai Publications new Delhi, 2004.
4. Sharma S.P, Fuels and Combustion, Tata Mc Graw Hill Publishing Company Ltd. New Delhi.1990.
5. Spalding D.B. Some Fundamentals of Combustion Better Worths Scientific Publications London, 1955.

PE 010 508 Electrical & Electronics Lab

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

PE010 601: Kinematics of Machinery

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

Text books:-

1. J. E. Shigley, J. J. Uicker, *Theory of Machines and Mechanisms*, McGraw Hill

Reference Books

1. R L Norton, Kinematics and Dynamics of Machinery, 1st ed., *Tata McGraw Hill Education Private Limited*, Delhi, 2009
2. S .S Rattan Theory of Machines, 3rd ed., *Tata McGraw Hill Education Private Limited*, Delhi, 2009
3. A. Ghosh, A. K. Malik, *Theory of Mechanisms and Machines*, Affiliated East West Press
4. A. G. Erdman, G. N. Sandor, *Mechanism Desian: Analvsis and svnthesis Vol I & II*,

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B	***Analytical/Problem solving questions*** All questions are compulsory. There should be at least one question from each module	***5 x 5 = 25***
C	***Descriptive/Analytical/Problem solving questions*** Two questions from each module with choice to answer one question	***5 x 12 = 60***
	Maximum Total Marks	100

PE010602: Heat and Mass Transfer

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.

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

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A	***Short answer questions (one/two sentences)*** All questions are compulsory. There should be at least one question from each module	***5 x 3 = 15***
B	***Analytical/Problem solving questions*** All questions are compulsory. There should be at least one question from each module	***5 x 5 = 25***
C	***Descriptive/Analytical/Problem solving questions*** Two questions from each module with choice to answer one question	***5 x 12 = 60***
	Maximum Total Marks	100

PE 010 603 Control and Automation

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

Objective:

- *To expose students to the breadth of knowledge required by the modern practice of control and automation.*

MODULE 1 (12 hours)

Introduction to Mechatronics – Sensors and transducers: characteristics. Displacement and position sensors. Resolvers and synchros. Velocity and motion sensors. Principle and types of force, temperature, vibration and acoustic emission sensors. Pneumatic, hydraulic and mechanical actuation systems used for mechatronics devices.

MODULE 2 (12 hours)

Micro Electro Mechanical Systems (MEMS): Fabrication methods - Working and applications of MEMS based accelerometer, pressure sensor and gyroscope Design of modern Computer Numerical Control (CNC) machines and mechatronics elements Machine structure: guide ways, drives. Bearings: anti-friction bearings, hydrostatic bearing and hydrodynamic bearing. Roller and ball screws. Measuring system for NC machines: direct and indirect measuring system.

MODULE 3 (12 hours)

System modelling - Mathematical models and basic building blocks of general mechanical, electrical, fluid and thermal systems. Adaptive control of machine tools. Mechatronics in Robotics-Electrical drives: DC, AC, brushless, servo and stepper motors. Harmonic drive.

MODULE 4 (12 hours)

Robotic force and pressure sensors: piezoelectric sensor and strain gauge. Tactile sensor. Proximity sensors: Magnetic, optical, ultrasonic, inductive, capacitive and eddy current methods. Range finders: ultrasonic and light based range finders

MODULE 5 (12 hours)

Robotic vision - Image acquisition: Vidicom and charge coupled device (CCD) cameras. Image processing techniques: histogram analysis, thresholding and connectivity method.. Case studies of mechatronics systems: Pick and place robot, automatic car park barrier system, and automobile engine management system.

Text books:-

1. W. Bolton, Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Person Education Limited, New Delhi 2007.
2. HMT, Mechatronics, Tata McGraw-Hill Publishing Company Ltd., New Delhi 2004.

References

1. K.P. Ramachandran, G.K. Vijayaraghavan, M.S. Balasundaram. Mechatronics: Integrated Mechanical Electronic Systems. Wiley India Pvt. Ltd., New Delhi 2008.
2. David G. Aldatore, Michael B. Histand, Introduction to Mechatronics and Measurement Systems, McGraw-Hill Inc., USA 2003.
3. Vijay K. Varadan, K. J. Vinoy, S. Gopalakrishnan, Smart Material Systems and MEMS: Design and Development Methodologies, John Wiley & Sons Ltd., England 2006.
4. Saeed B. Niku, Introduction to Robotics: Analysis, Systems, Applications, Person Education, Inc., New Delhi 2006.
5. Gordon M. Mair, Industrial Robotics, Prentice Hall International, UK 1998.

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A	***Short answer questions (one/two sentences)*** All questions are compulsory. There should be at least one question from each module	***5 x 3 = 15***
B	***Analytical/Problem solving questions*** All questions are compulsory. There should be at least one question from each module	***5 x 5 = 25***
C	***Descriptive/Analytical/Problem solving questions*** Two questions from each module with choice to answer one question	***5 x 12 = 60***
	Maximum Total Marks	100

PE010 604 Computer Aided Design & Manufacturing

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

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B	***Analytical/Problem solving questions*** All questions are compulsory. There should be at least one question from each module	***5 x 5 = 25***
C	***Descriptive/Analytical/Problem solving questions*** Two questions from each module with choice to answer one question	***5 x 12 = 60***
	Maximum Total Marks	100

PE 010 605 Production Engineering

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

Objectives:

- To learn on the various metal joining processes, welding design and quality control of welded joints.

MODULE 1 (12 hours)

Metal Joining: Classification-Welding power sources- Arc and Arc characteristics- Behaviour of arc with variation in current and voltage- Different arc welding processes- Welding electrodes - ISI specifications for electrodes- Electrode selection

MODULE 2 (12 hours)

Welding Metallurgy: Heat flow in welding – Metallurgical transformation in and around weldment – Implication of cooling rates – Heat affected zone (HAZ) – Weldability of plain carbon steels, Stainless steels, Cast iron, Aluminium and its alloys.

MODULE 3 (12 hours)

Design of weldments: Joint design- Weldability criteria-Residual stresses and distortion-Welding and Cladding of dissimilar materials- Overlaying and surfacing.

MODULE 4 (12 hours)

Newer welding processes: Plasma arc, Laser beam, Electroslag, and Ultrasonic welding- Joining by brazing- Soldering- Adhesive bonding Techniques for the production of defect free Welding

MODULE 5 (12 hours)

Quality Control in Welding: Testing of welded joints – Destructive Tests and Non-destructive tests (NDT). Quality assurance v/s Quality control - Weld quality - Discontinuities in welds, their causes and remedies - Quality conflicts.

Text books:-

1. Rossi, “Welding Engineering”
2. Nikodaco and Shansky, “Advanced Welding processes” – MIR Publications.
3. ASM hand book - welding

Reference books:

1. A.W.S., “Welding Engineering Handbook”
2. Udin, Funk and Wulf, “Welding for Engineers”
3. R.L Little, “Welding and Welding Technology”

PART	University Examination Question Paper Pattern	MARKS
A	***Short answer questions (one/two sentences)*** All questions are compulsory. There should be at least one question from each module	***5 x 3 = 15***
B	***Analytical/Problem solving questions*** All questions are compulsory. There should be at least one question from each module	***5 x 5 = 25***
C	***Descriptive/Analytical/Problem solving questions*** Two questions from each module with choice to answer one question	***5 x 12 = 60***
	Maximum Total Marks	100

PE010 606L01 Computational Fluid Dynamics

(Common with ME 010 606L01)

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

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B	***Analytical/Problem solving questions*** All questions are compulsory. There should be at least one question from each module	***5 x 5 = 25***
C	***Descriptive/Analytical/Problem solving questions*** Two questions from each module with choice to answer one question	***5 x 12 = 60***
	Maximum Total Marks	100

PE 010 606 L02 Foundry and Welding Technology

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

Objectives

- *To learn melting and casting processes*
- *To understand welding processes in detail.*

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.
3.

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.

PART	University Examination Question Paper Pattern	MARKS
A	***Short answer questions (one/two sentences)*** All questions are compulsory. There should be at least one question from each module	***5 x 3 = 15***
B	***Analytical/Problem solving questions*** All questions are compulsory. There should be at least one question from each module	***5 x 5 = 25***
C	***Descriptive/Analytical/Problem solving questions*** Two questions from each module with choice to answer one question	***5 x 12 = 60***
	Maximum Total Marks	100

PE010 606L03: Finite Element Analysis

Teaching scheme **Credits:** 4
2 hours lecture and 2 hour 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)

Introductory Concepts: Introduction to FEM. Brief History. General FEM procedure. Applications of FEM in various fields. Advantages and disadvantages of FEM.
Differential Equations in different fields : Types of Differential Equations. Primary and Secondary Variables and types of Boundary Conditions.
Approximate solution of differential equations-- Weightaed residual techniques, collocation, Least squares and Galerkin methods.

Module II (12 hours)

FEM Procedure : Definitions of various terms used in FEM likeelement, order of the element, internal and external node/s, degree of freedom, primary and secondary variables, essential boundary conditions, natural boundary conditions, homogeneous and nonhomogeneous boundary conditions.
Minimization of a functional. Principle of minimum total potential. Piecewise Rayleigh-Ritz method. Comparison with weighted residual method.

Module III (12 hours)

Piecewise approximations. Basis of Finite Element Methods. Formulation of matrix method--.stiffness matrix.; transformation and assembly concepts.
Example problems in one dimensional structural analysis (Plane Trusses, Bar and Beam) and heat transfer.

Module IV (12 hours)

Two dimensional finite element formulations. Three nodded triangular element, four nodded rectangular element, compatibility, four nodded quadrilateral element, eight nodded quadrilateral element.
Various types of 2-D-elements Application to plane stress, plane strain and axisymmetric problems.

Module V (12 hours)

Natural coordinates and coordinate transformations. Isoperimetric elements. Applications to two and three-dimensional problems
Convergence criterion, patch test and errors in finite element analysis. Method of Elimination.

Text Books

1. Robert D.Cook, "Concepts and applications of Finite Element Analysis", Wiley India, Fourth Edition, 2003.
2. Daryl L.Logan, "A first course in the Finite Element Method", Cengage Learning, Fourth Edition, 2007.

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. Bathe, K.J. and Wilson, E.L., "Numerical Methods in Finite Elements Analysis", Prentice Hall of India, 1985.

PART	University Examination Question Paper Pattern	MARKS
A	***Short answer questions (one/two sentences)*** All questions are compulsory. There should be at least one question from each module	***5 x 3 = 15***
B	***Analytical/Problem solving questions*** All questions are compulsory. There should be at least one question from each module	***5 x 5 = 25***
C	***Descriptive/Analytical/Problem solving questions*** Two questions from each module with choice to answer one question	***5 x 12 = 60***
	Maximum Total Marks	100

PE 010 606 L04 Financial Management

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

Objectives:

- *Familiarizing the students with the financial environment of business, especially the financial markets, imbibing knowledge about the decisions and decision variables involved in building the liability side of balance sheet of the firm, developing skills for interpretation business information and application of financial theory in financing related decisions*

MODULE 1 (12 hours)

Introduction - finance and related disciplines scope of financial management - functions -objectives of financial management - an overview on Indian financial system.

MODULE 2 (12 hours)

Financial analysis - financial statement analysis - ratio analysis.Statement of change in financial position

MODULE 3 (12 hours)

Working capital basis only Capital budgeting: nature - evaluation techniques - traditional technique - discounted cash flow techniques (NPV & IRR)

MODULE 4 (12 hours)

Working capital: nature - determinants - computation of working capital Sources of corporate finance - capital market.

MODULE 5 (12 hours)

Stock exchanges - equity - debt – other financial instruments - foreign investments and financing sources - Euro currency market, Euro issues, GDR, ADR etc.

Text books:-

1. Prasanna Chandra, *"Financial Management*", TMH
2. Shapiro A.C., *"Modern Corporate Finance",* Max well Macmillan

References:

1. Khan and Jain, *"Financial Management*", TMH
2. Brealey and Onyers, *"Principles of corporate Finance*", McGraw Hill
3. Pandey I.M., *"Financial Management",* Vikas publisher

PART	University Examination Question Paper Pattern	MARKS
A	***Short answer questions (one/two sentences)*** All questions are compulsory. There should be at least one question from each module	***5 x 3 = 15***
B	***Analytical/Problem solving questions*** All questions are compulsory. There should be at least one question from each module	***5 x 5 = 25***
C	***Descriptive/Analytical/Problem solving questions*** Two questions from each module with choice to answer one question	***5 x 12 = 60***
	Maximum Total Marks	100

PE010 606L05: Industrial Hydraulics

(Common with ME 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.*

PART	University Examination Question Paper Pattern	MARKS
A	***Short answer questions (one/two sentences)*** All questions are compulsory. There should be at least one question from each module	***5 x 3 = 15***
B	***Analytical/Problem solving questions*** All questions are compulsory. There should be at least one question from each module	***5 x 5 = 25***
C	***Descriptive/Analytical/Problem solving questions*** Two questions from each module with choice to answer one question	***5 x 12 = 60***
	Maximum Total Marks	100

PE 010 606 L06 Micro Electro Mechanical Systems (MEMS)

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

Objectives:

- To understand the terminology, operation and performance of different MEMS systems and solid state sensors
- To understand different types of advanced deposition process.

MODULE 1 (12 hours)

Science For Microsystems:- molecular theory, doping, diffusion, plasma physics and electrochemistry. Mechanics For Microsystems: - static bending of thin plates, mechanical vibrations, thermomechanics and fracture mechanics, problems. Thermo Fluid For Microsystems:-incompressible fluid flow in microconduits, fluid flow in submicrometer – overview of heat conduction in solids, heat conduction in multilayerd thin films, heat conduction in solids in submicrometer scale.

MODULE 2 (12 hours)

Scaling Laws In Miniaturization:- scaling in geometry, rigid body dynamics, electroststic forces, electromagnetic forces, electricity, fluid mechanics and heat transfer – materials for MEMS.

MODULE 3 (12 hours)

Fabrication Process: Ion implantation – diffusion - oxidation- CVD:- principle, structure, reactions, rate of deposition, different types of CVD, enhanced CVD – PVD: principle, structure, reactions, different types of PVD, magnetron sputtering etc.

MODULE -4 (12 hours)

Micro Sensors: - acoustic wave, bio, chemical, optical and thermal sensors. Micro Actuation: - by thermal force, shape memory alloys, piezoelectric crystals and electrostatic forces. Micro Actuators: –micro grippers, motor, valves, pumps and micro fluidics, fluid resistance in micro channels, capillary electrophoresis.

MODULE – 5 (12 hours)

Design of pressure sensors – design of accelerometers – design of resonant micro sensors, stress and strain in thin films etc. Micro machined amplitude modulated and waveguide optical sensors - micro machined optical pressure sensor – micro machined Bragg gratings - micro machined interferometric distance sensors - micro machined optochemical and bio sensors - micro machined nano probes.

Text books:-

1. Jaeger R.C.,Introduction to Microelectronic Fabrication, Wiley, 1989
2. Lawrence J.Kamm, Understanding Electro – Mechanical Engineering, An Introduction to Mechatronics, Prentice Hall, 2000.

References:

1. M.Elwenspoek, Silicon Micromachining, Cambridge Press, 1998
2. Marc J. Madou., Fundamentals of Microfabrication, The science of miniaturization, IEEE press
3. Marc Madou, Fundamentals of Micro fabrication, CRC Press, 1997
4. Rai Choudhury P., MEMS and MOEMS technology and applications, PHI learning, New Delhi.
5. StephenD Senturia, Microsystem Design, Kluwer Academic Publishers, 2003
6. Trimmer, Micromechanics and MEMS, IEEE Press, 1997.
7. Tai Ran Hsu, MEMS and Microsystems design and manufacture, TMH, New Delhi.

PART	University Examination Question Paper Pattern	MARKS
A	***Short answer questions (one/two sentences)*** All questions are compulsory. There should be at least one question from each module	***5 x 3 = 15***
B	***Analytical/Problem solving questions*** All questions are compulsory. There should be at least one question from each module	***5 x 5 = 25***
C	***Descriptive/Analytical/Problem solving questions*** Two questions from each module with choice to answer one question	***5 x 12 = 60***
	Maximum Total Marks	100

PE 010 607 Metrology Laboratory

Teaching scheme **Credits:** 2

3 hours practical per week

Objectives:

- *Understanding of various types mechanical measurement equipments*

List of Experiments

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 palte, 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, 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 using 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, holetest, 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.

PE 010 608 Machine Tools Laboratory

Teaching scheme **Credits:** 2

3 hours practical per week

Objectives:

- *Understanding of various types of machines and their mechanisms, manufacturing processes of machine tool components, machine parts and components of all types of machines included in the equipment list*

List of Experiments

1. Experiment on arc and gas welding: - butt welding and lap welding of M.S. sheets. - **1 practice.**
2. Experiment on shaping machine: - flat surfaces, dovetail cutting – grooving, keyway cutting etc. - **2 practices.**
3. Experiment on slotting machine: - flat surfaces, dovetail cutting – grooving, keyway cutting etc. - making hexagonal hole using slotting machine. - **1 practice.**
4. Experiment on lathe:- Facing, plain turning, step turning and parting - groove cutting, knurling and chamfering - form turning and taper turning - eccentric turning. - **3 practices.**
5. Experiment on thread cutting: - single and multistart external and internal threads, square and V-threads. - **1 practice.**
6. Disassembly and assembly of small assemblies such as tail stock, bench vice, screw jack etc. - **1 practice.**
7. Experiment on drilling machine: - drilling, boring, reaming and counter sinking – taping – study of reamers and taping. - **1 practice**.
8. Study and demonstration of N.C. machines:- programming, simulation and demonstration exercises involving plane taper and form turning etc. - **3 practices.**
9. Experiment on milling machine: - 1 - plane milling, keyway cutting, cutting of splines - **1 practice.**
10. 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.**
11. 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.**

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

A detailed report on the work carried out is to be prepared. 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

PE 010 701 Tool Engineering and Design

Teaching scheme **credits: 4**

2 hours lecture and 2 hour tutorial per week

Objectives

- *To understand the principles, functions and design practices of Jigs, Fixtures and dies for press working*
- *To understand the Principles of jigs and fixtures design, locating principles, locating elements and clamping Devices*

MODULE 1 (12 hours)

Locating methods: - methods, degrees of freedom, pins, vertical holding, radial location, diamond pins - principles of pin location – V locators - tool forces in different processes - principle of clamping:- clamping types – quick action clamping, power clamping etc. - elements - work holding principle for irregular and round surfaces - rigid and elastic holding - types of work holders –work holder selection – analysis of clamping forces:- strap clamp calculations, clamping force analysis of toggle and screw clamp.

MODULE 2 (12 hours)

Indexing devices: - linear indexing, rotary indexing etc. - Drill jigs: - types - leaf jigs, box jigs, channel jigs, template jigs and indexing jigs – chip formation in drilling –types of drill bushings.Types of fixtures: - economics of fixture - vise fixtures –types and details of milling fixtures, requirements of milling fixtures, special vice jaws - facing, straddle, gang, index, rotary and reciprocal milling fixtures - types and details of boring, slotting, broaching fixtures.

MODULE 3 (12 hours)

Types and details of lathe fixtures, chucks, face plate, collets, mandrels, etc. - Types and details of grinding fixtures - Welding fixtures: - gas, arc and resistance welding fixtures – tooling for soldering and brazing - modern jigs, hydraulic and pneumatic fixtures - tool holding methods for numerical control - tool magazines – vibration isolated tool holders.

MODULE 4 (12 hours)

Fundamentals of die cutting operations – cutting action in punch and die operations –die clearance- types of die construction – pilots – strippers and pressure pads.

MODULE 5 (12 hours)

Bending dies, spring back, bend allowances – forming dies –drawing operations –variables affects metal flow in drawing – determination of blank size – drawing force.

Text Books: -

1. Donaldson, Lecain and Goold Tool Design, McGraw Hill, New York, 1976
2. Basu S.K Design of machine tools, Allied publishers, Bombay, 1965
3. Elanchezian C Design of Jig and fixture and press tools, Esawr press, Chennai
4. SME Tool and Manufacturing Engineers Handbook, Volume 1: Machining

References:-

1. Edward G. Hoffman Jig and fixture design, Delmar Learning
2. Boyes E. William Jigs. & Fixtures & Gauges, SME 1st Edn. 1986
3. Erik Karl Henriksen Jig and fixture design manual
4. Gopal Chandra Sen and Amitabha Bhattacharya Principles of Machine Tools, New Central Book Agency, Calcutta, 1967
5. Henriksen E. K Jig and Fixture Design Manual, Industrial Press, New York, 1973
6. Joshi P .H Jigs & Fixtures, Tata McGraw Hill Pub. Co. Ltd., 1999
7. Kempster M.H.A An Introduction to Jig and Tool Design, ELBS 3rd Edn. 1974
8. Koenigsberger F Design Principles of Metal Cutting Machine Tools, Macmillan
9. SME Die Design Handbook, 3rd Edition, 1990

PE 010 702 Operations Management

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.

PE 010 703 Bulk Deformation Process

Teaching scheme **credits: 3**

2 hours lecture and 1 hour tutorial per week

Objective

- *To impart basic knowledge about different types of forging, rolling, extrusion etc..*

MODULE 1 (12 hours)

Forging: - open die forging – forces and work deformation under ideal condition – forging of a rectangular work piece in plane strain – forging of a solid cylinder work piece – forging under sticking condition – deformation zone geometry – impression die forging – closed die forging – miscellaneous forging operations – defects in forging - forgeability – die materials.

MODULE 2 (12 hours)

Radial forging: process, advantages, applications, examples - Rotary forging: advantages, applications, machines, dies, examples - Precision forging: advantages, process, applications, tooling design and process control considerations, selection of process temperature, examples - Powder forging: material and process considerations, metal flow, mechanical properties, applications, examples.

MODULE 3 (12 hours)

Rolling: - mechanics of flat rolling –roll pressure distribution – determination of netural point – front and back tension – roll forces – roll torque and power – forces in hot rolling – friction – roll deflection and flattening – spreading – defects in rolling – residual stress –vibration and chatter in rolling - miscellaneous rolling operations

MODULE 4 (12 hours)

Extrusion: - metal flow – mechanics of extrusion: ideal deformation, ideal deformation and friction, actual forces, optimum die angle, forces in hot extrusion - miscellaneous extrusion operations – defects in extrusion.

Mechanics of rod and wire drawing:- ideal deformation, ideal deformation and friction, redundant work of deformation, die pressure, drawing at elevated temperature, die angle, maxium reduction per pass, drawing of flat strip, drawing tubes – defects in drawing – swaging.

MODULE 5 (12 hours)

Rubber forming and hydroforming – spinning, conventional and shear spinning – tube spinning – high energy rate forming: explosive, electro hydraulic, magnetic pulse and super plastic forming – deep drawing, ironing, deep drawability, earing, punch force – different tests for formability.

Text Books: -

1. Ghosh A and A.K.Mallik Manufacturing Science, Affiliated East-West Press, New Delhi
2. Dieter George E Mechanical Metallurgy, McGraw Hill Book Co

References:-

1. Durelli, Phillip's & Tsao Introduction to the theory of theoretical and Experimental analysis of stress & strain - McGraw Hill Book Co., 1953
2. Kurt Lange Hand Book of Metal Forming
3. ASTME Die Design Handbook
4. Avitzur B Metal Forming: Processes & Analysis, McGraw-Hill Book Co
5. Hoffman O and Sachs G Introduction to the theory of Plasticity – Metal Forming applications – McGraw Hill Book Co
6. Johnson W & Mellur P.B Plasticity for mechanical engineers – D.Van Nostrand co. London
7. Pearson C.E. and R.N. Perkins The extrusion of metals, John Wiley and sons, NY, 1960
8. Rowe G.W An Introduction to the Principles of Metal Working, Edward Arnold Ltd., London –1990
9. Rowe R Principles of Metal working, Amold London
10. Sach G Fundamentals of Working of Metals, Pergamon Press

PE 010 704 Theory of Metal Forming

Teaching scheme **credits: 3**

2 hours lecture and 1 hour tutorial per week

Objectives

- *To describe the basic principles of metal forming and to provide a comprehensive coverage of various metal forming techniques*

MODULE 1 (12 hours)

Theory of deformation:- **Theory of stress**: - components of stress tensor, principal areas and stresses, maximum shear stress, two dimensional stress systems, Mohr's circle for plane stress, problems. **Theory of strain**: - strain components, strain rate, stress strain relation.

MODULE 2 (12 hours)

Basic theory of plasticity: - Assumptions in plasticity, flow conditions, Von-Mises yield criteria, geometrical representation of Tresca and Von-Mises yield criteria, Levy von Mises stress strain rate law. Slip line field theory, upper and lower bound theorems.

MODULE 3 (12 hours)

Theory of metal forming process: - Forging: - forging of a rectangular plate under conditions of plane strain and upper bound approach, forging of a solid disc on free body equilibrium and upper bound approaches, annulus disc upper bound approach, forging defects.
Drawing: - Drawing of solid rods through conical die, drawing of solid circular rod by upper bound approach, drawing of pipes over floating mandrel and wire drawing.

MODULE 4 (12 hours)

Extrusion:-Extrusion force in the plane extrusion of a rectangular blank, hydrostatic extrusion analysis, analysis of sinking of a thin walled tube, extrusion defects.
Rolling: - Deformation zone in rolling, conditions for biting of strip by rolls, equilibrium approach to rolling, drawing with stationary dies, rolling defects.

MODULE 5 (12 hours)

Sheet Metal Working: classification of presses and press tool operations -working principle, description, operation and applications of simple, compound, combination and progressive press tools – formability tests for sheet metals, erichsen and fukui tests, forming limit diagrams and shape analysis concepts

Text Books: -

1. Hoffman O and Sachs G — Introduction to the theory of Plasticity – Metal Forming applications – McGraw Hill Book Co.

2.	Johnson & Mellur	Engineering Plasticity – Van Nostrand – Reinhold Co.
3.	Johnson W & Mellur P.B.	Plasticity for mechanical engineers – D.Van Nostrand co. London.
4.	Mendelson	Introduction to Theory of Plasticity.

Reference Books:-

1	Durelli, Phillip's & Tsao	Introduction to the theory of theoretical and Experimental analysis of stress & strain - McGraw Hill Book Co., 1953.
2	Kurt Lange	Hand Book of Metal Forming.
3	ASTME	Die Design Handbook.
4	Avitzur B.	Metal Forming: Processes & Analysis, McGraw-Hill Book Co.
5	Dieter George E.	Mechanical Metallurgy, McGraw Hill Book Co.
6	Ghosh A & A.K.Mallik	Manufacturing Science, Affiliated East-West Press, New Delhi.
11	Pearson C.E. and R.N. Perkins	The extrusion of metals, John Wiley and sons, NY, 1960.
12	Prager W and Hodge P.G	Theory of plastic solids, Chapman & Hall Ltd, London 1951
13	Rowe G.W.	An Introduction to the Principles of Metal Working Edward Arnold Ltd., London –1990.
	Rowe R	Principles of Metal working, Amold London.
15	Sach G	Fundamentals of Working of Metals, Pergamon Press.
16	Tumoshinko and Goodier	Theory of Elasticity - McGraw Hill, Book Co.

PE 010 705 Advanced Manufacturing Process

Teaching scheme **credits: 3**

2 hours lecture and 1 hour tutorial per week

Objectives

- *To impart basic knowledge about different machine tools and machining processes.*

MODULE 1 (12 hours)

Drilling:- drilling machines – types of drills - tool material- nomenclature of drill point –drill wear and sharpening - chip control and chip breakers-cutting forces-drill bushings-counter boring, spot facing, counter sinking. Boring: - machines- tool material -nomenclature of boring tools –tool holders –tool wear compensation and chip control. Reaming: - types of reamers - tool material- nomenclature of reamers- wear and re sharpening – cutting forces – bushings – deep hole drilling - trepanning.

MODULE 2 (12 hours)

Planing: - machines - tool material -nomenclature of planing tools –cutting forces. Shaping :- machines - tool material -nomenclature of planing tools. Gear cutting:- gear milling machines – principle of hobbing process – hobbing techniques –hobbing cycles – hob size, flutes, material, etc.- hob wear –spur, helical gear hobbing, copy hobbing.

MODULE 3 (12 hours)

Gear shaping – production of tapers gears – fundamentals of work clamping – bevel gear cutting – gear finishing processes.

MODULE 4 (12 hours)

Thread production processes: - screw cutting on lathe – thread chasing – thread milling – thread whirling – die threading – tapping – thread rolling – thread grinding.

MODULE 5 (12 hours)

Honing: - machines, methods of honing, honing stones, honing tools, cutting fluids.

Lapping: - hand lapping - lapping machines –lapping finishes – lap materials – lapping medium.

Super finishing equipments - Super finishing stones – cutting conditions of super finishing - Super finishing fluids.

Text Books: -

1. HMT, Production Technology, Tata McGraw Hill
2. Kalpakjian, Manufacturing Engineering & Technology, Addison – Wesley, 4nd edn.

References:-

1. Metcut research, Machinablity Data Center Vol.1 & 2, Metal cut research associates, Cincinnati

PE 010 706L01 Design of Cellular Manufacturing

Teaching scheme **credits: 4**

2 hours lecture and 2 hour tutorial per week

Objectives

- *To understand the basic concepts of group technology, Cellular manufacturing systems and their applications.*

MODULE 1 (12 hours)

Introduction to Group Technology (GT), Limitations of traditional manufacturing systems, characteristics and design of groups, benefits of GT and issues in GT.

MODULE 2 (12 hours)

Cellular Manufacturing System (CMS) planning and design: Problems in GT/CMS. Design of CMS - Models, traditional approaches and non-traditional approaches -Genetic Algorithms, Simulated Annealing, Neural networks.

MODULE 3 (12 hours)

Implementation of GT/CMS: Inter and Intra cell layout, cost and non-cost based models, establishing a team approach, managerial structure and groups, batch sequencing and sizing, life cycle issues in gt/cms.

MODULE 4 (12 hours)

Performance measurement and control: Measuring CMS performance - Parametric analysis - PBC in GT/CMS, cell loading, GT and MRP - framework.

MODULE 5 (12 hours)

Economics of GT/CMS: Conventional Vs group use of computer models in GT/CMS, Human aspects of GT/CMS - cases.

Text Books: -

1. Kamrani, A.K, Parsaei, H.R and Liles, D.H. (Eds), "Planning, design and analysis of cellular manufacturing systems", Elsevier, 1995.

References:-

1. Askin, R.G. and Vakharia, A.J., G.T "Planning and Operation, in The automated factory-Hand Book: Technology and Management", Cleland.D.I. and Bidananda, B (Eds), TAB Books , NY, 1991.
2. Burbidge, J.L. Group "Technology in Engineering Industry", Mechanical Engineering pub. London, 1979. Irani, S.A. "Cellular Manufacturing Systems", Hand Book.

PE 010 706L02 Industrial Tribology

Teaching scheme **credits: 4**

2 hours lecture and 2 hour tutorial per week

Objectives

- *To have knowledge about the various modes of friction, wear mechanisms, types of lubrication and bearings and also the various surface engineering techniques*

MODULE 1 (12 hours)

Friction: Nature of surfaces – Mechanism of friction – Laws of friction and friction theories – Merits and demerits . Wear : Classification of wear – Theories of wear – Stages of Cohesive wear – Quantitative relationship for abrasive wear – Minor types of wear – Factors affecting wear .

MODULE 2 (12 hours)

Lubrication : Role of lubrication in present day practice – Fundamentals of viscosity andviscous flow – Flow through capillary tubes – Parallel plates – Radial flow between parallelcircular plates – Continuity equation and Raynold's equation . Viscosity and Viscometers – Starsor Viscometer – Falling sphere viscometer – SaybeltUniversal Viscometer – Viscosity index.

MODULE 3 (12 hours)

Analysis of hydrostatic oil pads – Load carrying capacity – Oil flow – Power loss – Application to thrust bearing , use of restrict hydro static squeeze films .

MODULE 4 (12 hours)

Analysis and application of Hydrodynamic Lubrication – Load carrying capacity, power loss and friction in ideal journal bearings – Use of linkage factors – Significance of Sommerfeld number – Eccentricity ratio – Unit load.

MODULE 5 (12 hours)

Detailed discussion on different surface characterization methods, Ra, Rt, Rz etc. and its measurement techniques.

Text Books: -

1. Basu, Sen Gupta and Ahuja, Fundamentals of Tribology, PHI.

References:

1. Sushil Kumar and Srivatsava, Tribology in Industry, S.Chand Co.
2. Majumdar .B.C., Tribology

PE 010 706L03 Lean and Agile Manufacturing

Teaching scheme **credits: 4**

2 hours lecture and 2 hour tutorial per week

Objective

- *To acquaint the student with the fundamental aspects related to lean manufacturing and their implementation*

MODULE 1 (12 hours)

Introduction To Lean Manufacturing: Meaning of lean – prerequisites of becoming lean in manufacturing systems – ford Production System (FPS) – phases of change – education and training – new measurable in FPS – managing change in a large corporation.
Lean Manufacturing Practices: System model of lean manufacturing – lean supplier to system sub model – core production system sun model – Interaction between production worker influence and production strategies – performance impacts of the lean manufacturing system, - relationship between lean manufacturing practices and performance measures.

MODULE 2 (12 hours)

Implementing Lean Manufacturing: Lean manufacturing program – defining lean manufacturing principles – lean flow – two paths of implementing lean manufacturing – pitfalls in implementing lean manufacturing.
Successful Implementation Of Lean Manufacturing: Meaning and definition of agility – forces pulling towards agility – three consequences of converging physical products, information and services – empowerment – enterprise integration – concurrent operations.

MODULE 3 (12 hours)

Introduction To Agile Manufacturing: Meaning and definition of agility – forces pulling towards agility – three consequences of converging physical products, information and services – empowerment – enterprise integration – concurrent operations.
Customizing Agile Business Strategies: Model for agile relationships – products, services and enrichment of each customer – enrichment chain – moving from one time product to providing customer – enrichment – steps in customising the agile business strategies – analysis of company – overall opportunity analysis – comparison with current products – initial plan of market presence – refining the plan – analysing the barriers to change – planning the internal realignment of the company – role of strategic planning departments.

MODULE 4 (12 hours)

Barriers to Assimilating Agility: Generally accepted accounting principles – activity based costing – time based costing fully utilised balanced line fallacy – budgeting procedures – dysfunctional organisation and information systems – betrayal of trust – not sharing information – external barriers.

MODULE 5 (12 hours)

Infrastructure And Enabling Systems For Agility: Infrastructure for agility – enterprise elements – customer dialogue and support – communication and information – co-operation and teeming – continuous improvement and change – enterprises wide concurrency – environmental enhancement – flexible and rapidly responding operations – people support – supplier support – enabling subsystems – continuous education and training – customer interactive systems – lean organisation and methods – modular re configurable process components – performance metrics and evaluation – waste management and elimination.

Text Books: -

1. Liker, J.K. (ed.), 1997, "Becoming Lean", Productivity Press, Oregan.
2. Goldman, S.L., Nagal, R.N. and Preiss, K. 1995, Agile competitors and Virtual organizations, Van Nostrand Reinhold, New York.

Reference: -

1. Montgomery, J.C. and Levine, L.O., 1995. "The transition to agile manufacturing" – Staying flexible for competitive advantage, ASQC Quality Press, Wisconsin**.**

PE 010 706L04 Supply Chain Management

Teaching scheme **credits: 4**

2 hours lecture and 2 hour tutorial per week

Objectives

- *To understand the inventory control techniques, purchasing functions and supply chain strategies of different kinds of industries.*

MODULE 1 (12 hours)

Introduction to supply chain management: Supply chain basics, decision phases in supply chain, supply chain flows, supply chain efficiency and responsiveness, supply chain integration, process view of a supply chain, uncertainties in supply chain, key issues in supply chain management, drivers of supply chain performance.

MODULE 2 (12 hours)

Demand forecasting in Supply Chain: Role of forecasting in supply chain, components of a forecast, forecasting methods, estimating level, trend and seasonal factors, Holt's model, Winter's model, measures of forecast error.

MODULE 3 (12 hours)

Supply Chain Inventory: Role of cycle inventory in supply chain, economies of scale, lot sizing for a single product, lot sizing for multiple products, quantity discounts, trade promotions, Price discrimination.Role of safety stock in supply chain, inventory replenishment policies, measures of product availability.

MODULE 4 (12 hours)

Transportation decisions: Role of transportation in supply chain, factors affecting transportation decisions. Routing and scheduling in transportation. Definition of logistics, logistics and SCM, international considerations, inbound logistics, internal logistics and outbound logistics. Reverse logistics, Green supply chain.

MODULE 5 (12 hours)

Coordination and Technology in supply chain: Supply chain coordination, Bullwhip effect, developing relationships in the supply chain, resolving conflicts in supply chain relationships.Information systems and supply chain management, role of information technology in supply chain, IT applications for supply chain management. Role of E-business in supply chains.

Text Books: -

1. Agarwal D.K. A text book of logistics and supply chain management, Macmillan, 2003.

2. Hand Field Robert B., NicholsJr., Ernest L — Introduction to supply chain management, Prentice Hall, New Jersey, 1999.
3. Raghuram R. and N. Rangaraj. — Logistics and supply chain management, Macmillan, 2001.

References: -

1	Agarwal D.K.	A text book of logistics and supply chain management, Macmillan, 2003.
2	Hand Field Robert B., Nichols Jr., Ernest L	Introduction to supply chain management, Prentice Hall, New Jersey, 1999.
3	Raghuram R. and N. Rangaraj.	Logistics and supply chain management, Macmillan, 2001.
4	Roberta S. Russell, Bernard W. Taylor III,	Operations Management, PHI, 2003.
5	Simchi-Levi, D., Kaminsky, P.,andSimchiLevi, E.,	Designing & Managing the Supply Chain: Concepts, Strategies & Case studies. Second Edition, Tata McGraw-Hill Edition, 2003.
6	Sunil Chopra and Peter Meindl	Supply Chain Management, Pearson Education, 2001.

PE 010 706L05 Plant Engineering and Maintenance

(Common Syllabus with ME 010 706L01)

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

PE 010 706L06 Rapid Prototyping

Teaching scheme **credits: 4**

2 hours lecture and 2 hour tutorial per week

Objectives

- *To enable the student to gain knowledge on the different rapid prototyping systems*.

MODULE 1 (12 hours)

Introduction: Need - Development of RP systems – RP process chain - Impact of Rapid Prototyping on Product Development –Digital prototyping - Virtual prototyping- Rapid Tooling - Benefits- Applications. Reverse engineering and CAD modeling: Basic concept- Digitization techniques – Model Reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data Requirements.

MODULE 2 (12 hours)

geometric modeling techniques: Wire frame, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool path generation. Liquid based and solid based rapid prototyping systems: Stereolithography (SLA): Apparatus: Principle, per-build process, part-building, post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications.

MODULE 3 (12 hours)

Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and applications. laminated object manufacturing(LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

MODULE 4 (12 hours)

Powder based rapid prototyping systems: Selective Laser Sintering(SLS): Principle, process, Indirect and direct SLS- powder structures, modeling of SLS, materials, post processing, post curing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping(LENS): Processes, materials, products, advantages, limitations and applications– Case Studies.

MODULE 5 (12 hours)

Other rapid prototyping technologies: Three dimensional Printing (3DP):Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, strength and weakness, Applications and case studies. Shape Deposition Manufacturing (SDM): Introduction, basic process, shape

decomposition, mold SDM and applications. Selective Laser Melting, Electron Beam Melting – Rapid manufacturing.

Text Books: -

1. Rapid Prototyping: Theory and practice, Ali K. Kamrani, Emad Abouel Nasr, Springer, 2006.
2. Rapid Tooling: Technologies and Industrial Applications, Peter D.Hilton,Hilton/Jacobs, Paul F.Jacobs, CRC press, 2000.

References:

1. Rapid prototyping: Principles and applications, second edition, Chua C.K.,Leong K.F., and Lim C.S., World Scientific Publishers, 2003.
2. Rapid prototyping, Andreas Gebhardt, Hanser Gardener Publications, 2003.
3. Rapid Prototyping and Engineering applications: A tool box for prototype development,Liou W.Liou, Frank W.Liou, CRC Press, 2007.

PE 010 707 Metallurgy Laboratory

Teaching scheme **credits: 2**

3 hours of practical per week

Objectives

- *To observe and understand the structure of various metals and alloys*
- *To study the effect of heat treatment on the structure of metals and alloys*

Microstructure study - Specimen preparation - microstructure study of Steels - Cast iron and Brass. - Grain size measurement - Heat treatment study -Effect on Mechanical properties and microstructure of Steels, Cast iron, Brass and Aluminium. - Etching and microstructure studies using optical microscope.

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, modelling steps, results
30% - Viva voce

PE 010 708 CAD/CAM Laboratory

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 modelling (15 hours)

Creation of 3D models-Wireframe, Surface and Solid modelling techniques using CAD packages- Parametric modelling-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) Modelling of machine parts, brackets using 2D drawings
2) Modelling of surfaces using given master geometry
3) Parametric modelling 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, modelling steps, results
30% - Viva voce

PE 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.

PE 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.

PE 010 801 Composite Materials and Manufacturing

Teaching scheme **credits: 4**

3 hours lecture and 2 hour tutorial per week

Objectives

• *To impart the basic concepts of composite materials*

MODULE 1 (12 hours)

Composite Materials: - definition, characteristics, classification based on structure and matrices, structural, functional sensory and smart composites, advantages and limitations, history, industrial scene and application.
Reinforced Fibres: - high strength manmade (glass, carbon, aramid etc) and natural fibers, structure, characteristics, properties and applications.

MODULE 2 (12 hours)

Whiskers: - characteristics, properties and applications.
Polymer Matrix Composites (PMC): - thermoset, thermoplastic and elatromeric polymers, their properties. Manufacturing methods for thermoset, thermoplastic and elastomeric PMC. Their characteristics features, properties of composites made and their applications.

MODULE 3 (12 hours)

Metal Matrix Composites (MMC):- Metals, alloys used for MMC and their properties, manufacture of MMC, their properties, characteristics and applications.

MODULE 4 (12 hours)

Ceramic Matrix Composites (CMC):- classification of ceramics and their potential role as matrices. Ultra structure processing of ceramics, manufacture, properties and applications of CMC using fine ceramics, carbon, glass, cement and gypsum as matrices.

MODULE 5 (12 hours)

Post Processing Operations: - machining, cutting, polishing, welding of thermoplastic, PMC, bonding, riveting and painting. Advanced post processing methods like ultrasonic welding, plasma coating, laser machining.

Text Books: -

1. Chawla Krishana K. Composite Materials, Springer Verlag.

References:

1. Autar K. Kaw Mechanics of Composite Materials, CRC

PE 010 802 Non Conventional Machining Processes

Teaching scheme **credits: 4**

2 hours lecture and 2 hour tutorial per week

Objectives

- *To Provide knowledge on different non conventional machining process*

MODULE 1 (12 hours)

Electrical discharge machining (EDM): - machine, dielectric fluid, spark generation, electrodes, electrode materials, flushing, process characteristics and applications. Electrochemical machining (ECM):- machine, electrolytes and electrolyte systems, process characteristics, tooling and applications.

MODULE 2 (12 hours)

Ultrasonic machining (USM):- machine, tool holder, tool materials, tool holder, process characteristics and applications. Abrasive jet machining (AJM):- machine, nozzles, abrasive materials, carrier gas, process characteristics and applications.

MODULE 3 (12 hours)

Laser beam machining (LBM):- equipment, types of lasers, process characteristics and applications. Electron beam machining (EBM):- equipment, process characteristics and applications. Plasma arc machining (PAM):- equipment, selection of gas, process characteristics and applications Ion Beam Machining (IBM):- equipment, process characteristics and applications.

MODULE 4 (12 hours)

Power metallurgy: Preparation metal powers – Power characteristics: properties of fine power, size, size distribution, shape, compressibility, purity etc.- Mixing – Compaction techniques – Mechanism of sintering of single & multi phase materials - Sintering atmosphere – Finishing operations: heat treatment, surface treatment, impregnation treatment etc. – Impregnated bearings – Sintered oil-retaining bearing – Economics of p/m.

MODULE 5 (12 hours)

Advanced production methods: Rapid prototyping: background & definitions – Process methods: Stereolithography, selective laser sintering, fused deposition modeling, laminated object manufacturing, laser engineered net shaping, 3D welding –LIGA process. Mechanical advanced micromachining processes: - ultrasonic micromachining, electro discharge

micromachining, laser beam micromachining, electrochemical micromachining - abrasive based nano finishing processes with external control of forces.

Text Books

1. HMT, Production Technology, Tata McGraw Hill
2. Kalpakjian, Manufacturing Engineering & Technology, Addison – Wesley, 4nd edn.

References

1. Jain V.K. Introduction to micromachining, Narosa publishers.
2. Avner A.G., Physical metallurgy, TMH.

PE 010 803 Machine Design

Teaching scheme credits: 4

2 hours lecture and 2 hour tutorial per week

Module 1 (12 hours)

Introduction to Design: Introduction, Design philosophy, Common engineering materials, selection and their properties. General steps in design, Principles of standardization, Tolerances & fits.

Stresses in Machine parts- tension, compression and shear; elastic constants, working stress, factor of safety, bending and torsion, combined stresses.

Design for static loading, Modes of failure, Theories of failure, Stress Concentration, Stress intensity- Design for dynamic loading, Fatigue failure, Endurance limit, Fatigue diagram, Fatigue factors, Goodman and Soderberg lines.

Module 2 (12 hours)

Shafts: Torsion and bending of shafts, hollow shafts, design of shafts for strength and rigidity.

Keys: Effect of keyways, Design of keys.

Couplings: Design of rigid and flexible couplings.

Module 3 (12 hours)

Gears: Types of gears, strength of gear teeth, gear forces and their effects, formative number of teeth, lead, lead angle, basic geometry and nomenclature of meshed spur gear set, dynamic load, endurance load, wear loads, AGMA standards, Lewis equation for strength design and Lewis form factor, design for wear, design of gears such as spur gear and helical gear

Module 4 (14 hours)

Riveted joints: Lap joint, Butt joint, failures of riveted joint, strength of riveted joint, efficiency of riveted joint, design of longitudinal butt joint for boiler, design of circumferential lap joint for boiler

Welded joints: Lap joint, Butt joint, weld symbols parallel and transverse fillet welds, strength of welded joints, axially loaded welded joints, eccentrically loaded welded joints.

Module 5 (10 hours)

Pressure vessels: Design of thick and thin cylinders, Cylinders subjected to internal pressure and external pressure. Vertical and horizontal pressure vessels based on ASME Boiler and Pressure Vessel Code.

Data hand book is permitted to use in examination hall as specified in mechanical branch machine design syllabus.

Text Book

1. Mechanical Engineering Design : Joseph E. Shigley.

References

1. Design of Machine Elements : Bhandari V. B.
2. Machine Design : Black P. H.
3. Machine Design : Norton.
4. Machine Design : Sharma P. C. and Aggarwal D. K.

Electives III

PE 010 804 L01 Surface Engineering

Teaching scheme **credits: 4**

2 hours lecture and 2 hour tutorial per week

OBJECTIVE

- *Study about the development and application of surface engineering*

MODULE 1 (12 hours)

Tribology: Introduction to tribology, Wear: Types of wear - adhesive, abrasive, oxidative, corrosive, erosive and fretting wear, roles of friction and lubrication and wear testing.

MODULE 2 (12 hours)

Plating Processes: Fundamentals of electrodeposition, plating of nickel, chromium, tin and copper, pulsed plating, hydrogen embrittlement, plating adhesion, electroless plating, electrochemical conversion coating, selective plating for repair, plating properties, hard anodizing.Hardfacing processes: SMAW, GTAW, GMAW, FCAW, SAW, PAW, Oxy-AcetyleneWelding, Furnace fusing, Thermal -spray, flame spray processes - HVOF, Detonation gun and jet kote processes, hard facing consumables.

MODULE 3 (12 hours)

Special diffusion processes: Principle of diffusion processes – Boriding, Aluminising, Siliconising, Chromising, Sursulf - Selection of diffusion processes – Characteristics of diffused layer – micro structure and micro hardness evaluation – properties and applications.

MODULE 4 (12 hours)

Thin film coatings: Physical vapor deposition processes – Thermal evaporation - sputter coating - Ion plating – Chemical vapor deposition – reactive sputtering - TiC, TiN, Alumina, cBN, Diamond and DLC coatings. Machine, structure, properties and applications.

MODULE 5 (12 hours)

High energy modification and special processes: Electron beam hardening/ glazing, Laserbeam hardening / glazing ion inplantation, Composite surface created by laser and Electronbeam. Surface cements, Wear tiles, Electro spark deposition, fused carbide cloth, thermal /chemical,Ceramic coatings, centrifugal cast wear coatings, Wear sleeves and Wear plates.

Text Book

1. ASM Metals Handbook, Vol.5, “Surface Engineering”,Metals Park,Ohio, 1994.
2. Ernest Rabinowicz, “Friction and Wear of Materials”, 2nd edition, John Wiley & Sons,NY, 1995.

References:

1. Kenneth G.Budinski, “Surface Engineering for Wear Resistance”, Prentice Hall,Englewood Cliff, 1990.
2. Sudarshan T S, “Surface Modification Technologies – An Engineer’s guide”, MarcelDekker, New York, 1989.

PE 010 804 L02 Advanced Machining Process

(Common with ME 010 804L02)

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.

PE 010 804 L03 Cost Estimation and Optimization

Teaching scheme **credits: 4**

2 hours lecture and 2 hour tutorial per week

OBJECTIVE

- *To introduce the cost optimization techniques.*
- *To make cost estimation for various products after optimization.*

MODULE 1 (12 hours)

Cost Accounting-Cost Estimation Concepts, differences, steps involved, different types, cost grid uses. **Labour and Materials Costs** Labour cost-direct-Indirect, Estimation Labour cost variance -Material cost-Direct Indirect, Estimation material cost variance.

MODULE 2 (12 hours)

Overhead Cost Elements in overhead cost, various methods of absorbing overhead costs, MHR Calculation, overhead variance Problems, Introductions to activity based costing method. **Cost Calculations** Machined components, Welded components, Cast components and forged components, calculation of sales cost, case studies, and use of computers in cost estimation.

MODULE 3 (12 hours)

Cost Optimization Cost optimization techniques-Analytical, graphical, incremental methods for single and multi variable situations, Learning curve.
Optimum Machining Conditions Taylor's equation deriving the equation for optimum economic cutting velocity, selection of cutting speed for optimum cost, Process capability analysis.

MODULE 4 (12 hours)

Break Even Analysis Concept, applications and area of use, Value analysis steps in selection, Analysis and Implementation.

MODULE 5 (12 hours)

Group Technology and Productivity Group technology, objectives, Steps, methods of codification, productivity, concepts, Labour, Machine, and Material based productivity.

Text Books

1. Frederic, C., Jelen, C., and James, H. Black., "Cost and Optimization Engineering", McGraw Hill International Book Company, New Delhi, 1983.
2. Narang, C. B. S. and Kumar, V., "Production and Casting", Khanna Publishers, New Delhi, 1985.
3. Samuel Eilon, "Elements of Production and Control", MacMillan, 1985.

References

1. ASME, "Manufacturing Planning and Estimation-Hand Book", McGraw HillBook Company Inc. 1963.
2. Haslhurst, M., "Manufacturing Technology", ELBS, 1985.

PE 010 804 L04 Management Information Systems

Teaching scheme **credits: 4**

2 hours lecture and 2 hour tutorial per week

Module 1

Introduction: Meaning and definition – system approach – role of MIS to face increased complexity of business and management – system view of business – MIS organization within the company.

Conceptual information system design: Defining the problems – setting system objectives – establishing system constraints – determining information needs – determining information sources – developing alternate conceptual design and selecting one – documenting the conceptual design – preparing the conceptual design report.

Module 2

Detailed information system design: Informing and involving the organization – project management of MIS detailed design – identifying dominant and trade-off criteria – defining the subsystems – sketching the detailed operating subsystems and information flows – determine the degree of automation – informing and involving the organization again – inputs, outputs and processing – early system testing – propose an organization to operate the system – documentation – revisiting the manager-user.

Module 3

Evolution of information systems: Basic information systems – financial information systems – production / operations systems – marketing information systems – personnel information systems. Information system softwares – selection – complexity and errors.

Module 4

Information systems and decision making: Decision making and MIS – programmed and non programmed decision – MIS for making programmed decisions – decision-assisting information systems – components of decision support systems.

Module 5

Information technology and MIS: Comparison of manual and computer based information systems – conversation of manual to computer based systems – types of computer based applications in MIS – application of multimedia, internet, intranet and extranet technologies in MIS. E-business: Introduction – models – security.

Text Books

1. Henry C. Lucas Jr., *The analysis, design and implementation of information systems,* 4th Edition, McGraw Hill Company, New York, 1992.

2. Burch J. E., Strater F. R & Grudnikski G., *Information systems: theory and practice*, John Wiley and Sons, New York, 1987.

References

1. Murdick R. G., Ross J. E. & Claggett J. R., *Information systems for modern management*, 3rd Edition, Prentice Hall of India Private Ltd., India, 1992.

2. James A. O'Brien, *Management information systems: a managerial end user perspective*, Galgotia Publications, 1997.

PE 010 804 L05 Non Destructive Testing

(Common with ME 010 804L05)

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.

PE 010 804 L06 Simulation of Manufacturing Systems

Teaching scheme **credits: 4**

2 hours lecture and 2 hour tutorial per week

Objectives

- *To know about the technique of simulating actual industrial scenario*

MODULE 1 (12 hours)

Principle of Computer Modelling And Simulation: Monte Carlo simulation. Nature of computer modelling and simulation. Limitations of simulation, areas of application.
System and environment: Components of a system – discrete and continuous systems. Models of a system – a variety of modeling approaches.

MODULE 2 (12 hours)

Random Number Generation: Techniques for generating random numbers – Midsquare method – The midproduct method – Constant multiplier technique – Additive congruential method – Linear congruential method – Test for random numbers – The Kolmogorov – Smirnov test – the Chi-square test.
Random Variable Generation: Inverse transform technique – exponential distribution – uniform distribution – Weibull distribution Emprical continuous distribution – generating approximate normal variants – Erlang distribution.

MODULE 3 (12 hours)

Empirical Discrete Distribution: Discrete uniform distribution – poisson distribution – geometric distribution – acceptance – rejection technique for Possion distribution – gamma distribution.
Design And Evaluation Of Simulation Experiments: Variance reduction techniques – antithetic variables – verification and validation of simulation models.

MODULE 4 (12 hours)

Discrete Event Simulation: Concepts in discrete-event simulation, manual simulation using event scheduling, single channel queue – two server queue, simulation of inventory problem.

MODULE 5 (12 hours)

Important Event Simulation: Concepts in discrete-event simulation, manual simulation using event scheduling, single channel queue, two server queue, simulation of inventory problem.
Introduction to GPSS: Programming for discrete event systems in GPSS, case studies.

Textbooks: -

1. Jerry Banks & John S. Carson II, “Discrete Event System Simulation” Prentice Hall Inc., 1984.

2. Gordon G, “System Simulation”, Prentice Hall Ltd. 1991.

Reference: -

1. Narsingh Deo, “System Simulation with Digital Computer” Prentice Hall, 1979
2. Francis Neelamkovil, “Computer Simulation and Modelling”, John Wiley & Sons, 1987.
3. Ruth M. Davis & Robert M.O’Keefe, “Simulation Modelling with Pascal”, Prentice Hall Inc., 1989.

Electives IV

PE 010 805 G01 Industrial Safety

(Common with ME 010 805 G01)

Teaching scheme **credits: 4**

2 hours lecture and 2 hour 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.

PE 010 805 G02 Disaster Management

(Common with ME 010 805 G02)

Teaching scheme **credits: 4**

2 hours lecture and 2 hour 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

U.R. Rao : *Space Technology for Sustainable Development*

PE 010 805 G03 Nano Technology

(Common with ME 010 805 G03)

Teaching scheme **credits: 4**

2 hours lecture and 2 hour tutorial per week

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

PE 010 805G04 Human Resource Management

Teaching scheme **credits: 4**

2 hours lecture and 2 hour tutorial per week

Module 1

Dimensions of Human Behaviour, Self development, Perception, Motivation and Personality-concepts, theories and applications .Modes of values, beliefs, attitudes and intelligents in determining human behaviour. Group dynamics-nature of groups and group decision making. Leadership –nature and significance ,theories and styles.

Module 2

Conflict management, Transactional Analysis, Case studies.
Organizational development, Concepts of QWL-strategies for improved QWL, Organizational change, Resistance to change, Goals of organizational change and organizational development, Concept of organizational climate-health and effectiveness.

Module 3

Organizational culture- nature and characteristics, types, impact of culture in organizational behaviour, Motivation of person across cultures, Managerial leadership across cultures, Case studies.

Module 4

Human Resource Management –Concepts and objectives. Man power planning, Recruitment and selection, Training and development. Performance appraisal, Wage and salary administration, Grievance handling,

Module 5

Compensation policies, Safety and health maintenance, Labour legislation, Case studies.

Text book:-

1. Gary Dessler, Human Resource Management, Pearson Education.

References:

1. Fred Luthans, Organizational Behaviour, McGraw Hill.
2. Stephen P. Robbins, Organizational Behaviour, Pearson Education.
3. Uma Sekharan, Organizational Behaviour-Text and Cases, Tata Mc Graw Hill.
4. Scott ,Personnel Management ,Tata Mc Graw Hill.

PE 010 805 G05 Optimization Methods in Design

(Common with ME 010 805 G05)

Teaching scheme **credits: 4**

2 hours lecture and 2 hour 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.

PE 010 805 G06 Reliability Engineering

Teaching scheme **credits: 4**

2 hours lecture and 2 hour tutorial per week

Objectives

- *To apply engineering knowledge and specialist techniques to prevent or to reduce the likelihood or frequency of failures.*
- *To identify and correct the causes of failures that do occur, despite the efforts to prevent them*
- *To apply methods for estimating the likely reliability of new designs, and for analysing reliability data.*

MODULE 1 (12 hours)

Concepts of Reliability: Definition of reliability - definition of failure - classification of failures - measures of reliability - failure rate, Mean Time Between Failures (MTBF), Mean Time to Failure (MTTF) - derivation of the reliability function - reliability specifications.

MODULE 2 (12 hours)

Failure Patterns and Fitting Curves: The bath tub curve - early failure period, constant failure period, the wear out failure period -the Weibull distribution - the Weibull distribution lo describe the bath tub curve - estimation of Weibull parameters, Weibull probability plot.
Cost, Performance And Other Related Factors: Factors related to reliability - availability - utilization factor – system effectiveness - reliability and maintenance costs - factors affecting reliability and maintenance costs - eight basic stages in the achievement of reliability.

MODULE 3 (12 hours)

Design and Manufacture for Reliability; Customer or market specifications for reliability - the reliability of parts and components- basic rules, parts in series - design for system reliability - blocks or units in series, dealing with variations in parts, the use of value analysis redundancy, types, application.
Design For Ease of Operation: The effect of fatigue and working conditions - the layout of controls and tools - ergonomics. Design for ease maintenance: the importance of availability fault location routine - provision for fault location -test equipment fault correction – working conditions of the maintenance staff- instruction manuals - after sales service - stock control of spares.

MODULE 4 (12hours)

Manufacture for Quality and Reliability: The need for prototype tests - the quality standard - planning to achieve the required quality - quality and reliability control in service organizations.
Packaging and Transportation For Reliability: Objectives - preservation - packaging - transportation and subsequent storage. Reliability and the customer. The purchase of equipment - installation - commissioning a new system - maintenance - the meantime to

repair, maintainability, breakdown maintenance, scheduled or preventive maintenance - availability and costs.

MODULE 5 (12 hours)

Reliability, Prediction And Management: Reliability prediction and control - the need for reliability control, feasibility studies, prototype tests, manufacture and production testing - reliability management - reliability objectives, the people concerned with reliability co-ordination, training.

Text book: -

1. Rowland Caplan, “A Practical Approach to Reliability", 1982

References: -

1. Govil A.K., "Reliability Engineering", 1989.
2. Carter A.D.S. “Mechanical Reliability”, 1989.

PE 010 806 Production Process Laboratory

Teaching scheme **credits: 2**

3 hours of practical per week

Objectives

- *To familiarize the students with test procedures followed in foundry, casting and to practice various types of welding processes.*

Welding: Preparation of joints, Exercises on different types of welding - Metal arc welding, TIG welding, MIG welding, Gas welding and Resistance welding. Exercises on testing of weld joints – destructive and non–destructive.

Foundry & Casting: Testing of foundry sand and sand mould- Grain size sieve analysis, Green and Dry strength, (Tensile, Bending, Shear and Compressive strength), Hardness test, Permeability and Moisture content. Exercises in making moulds using single piece, split piece and three piece patterns. Melting & pouring practice. Inspection of castings.

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, modelling steps, results
30% - Viva voce

PE010 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.

PE010 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.