Polymer Engineering (PO)

EN010 301A: ENGINEERING MATHEMATICS II

(Common to all branches except CS & IT)

Teaching scheme **Credits: 4**

2 hours lecture and 2 hour tutorial per week

Objectives

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

MODULE 1 Vector differential calculus (12 hours)

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

MODULE 2 Vector integral calculus (12 hours)

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

MODULE 3 Finite differences (12 hours)

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

MODULE 4 Difference Calculus (12 hours)

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

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

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

Reference

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

EN010 302: Economics and Communication Skills

(Common to all branches)

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

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

Economics

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

Module II (6 hours)
Multinational corporations in India-impact of MNC's in the Indian economy
Globalisation-necessity-consequences
Privatisation-reasons-disinvestment of public sector undertakings
The information technology industry in India-future prospects

Module III (6 hours)
Direct and indirect taxes- impact and incidence- merits of direct and indirect taxes-progressive and regressive taxes-canons of taxation-functions of tax system-
tax evasion-reasons for tax evasion in India-consequences-steps to control tax evasion
Deficit financing-role-problems associated with deficit financing

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

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

Text Books

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

References

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

Communication Skills

Objectives

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

MODULE – 1 (15 hours)
INTRODUCTION TO COMMUNICATION
Communication nature and process, Types of communication - Verbal and Non verbal, Communication Flow-Upward, Downward and Horizontal, Importance of communication skills in society, Listening skills, Reading comprehension, Presentation Techniques, Group Discussion, Interview skills, Soft skills

MODULE – II (15 hours)
TECHNICAL COMMUNICATION
Technical writing skills- Vocabulary enhancement-synonyms, Word Formation-suffix, affix, prefix, Business letters, Emails, Job Application, Curriculum Vitae, Report writing- Types of reports

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

REFERENCES

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

PO010 303: Polymer Science - I

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

Objectives

- *To impart the fundamental concepts of polymeric materials*
- *To familiarize polymerization reaction mechanisms and kinetics*

Module 1 (10 hours)
Importance in everyday life, Functionality of monomers- bi-functional systems, poly functional systems. polymerisability, degree of polymerization. Differences between polymer and low molecular weight systems, Classification- examples for natural polymer, synthetic polymer, homo polymer, copolymer, inorganic polymer and biopolymer. Idea about linear

polymer, branched polymer, ladder polymer, crosslinked polymer, homochain polymer and hetero-atomic chain polymers. Nomenclature

Module 2 (15 hours)

Need for average polymer molecular weight, Different averages in polymer molecular weight- Number average, weight average, viscosity average, z- average molecular weights, molecular weight distribution, polydispersity index, simple numerical problems to illustrate average molecular weight, basic principles of the following methods: end group analysis, colligative property measurements, osmometry, vapour phase osmometry, light scattering, ultracentrifugation, viscometry and gel permeation chromatography

Module 3 (10 hours)
Addition polymerization, mechanism and kinetics of free radical polymerization, cationic polymerization and anionic polymerization, free radical initiators, control of molecular weight, inhibition, autoacceleration, chain transfer

Module 4 (15 hours)
Condensation polymerisation, Carother's equation, gelation, coordination polymerisation, Ziegler-Natta catalysts, ring opening polymerization, copolymerization, different types of copolymers, monomer reactivity ratio, copolymer equation

Module 5 (10 hours)
Polymerization techniques, bulk polymerization, solution polymerization, suspension polymerization, emulsion polymerization, interfacial polymerisation

References

1. F.W. Billmeyer, Textbook of Polymer Science, Wiley international publishers, 1984.
2. Joel R. Fried, Polymer science and Technology, Prentice Hall, NJ, 1995
3. J.M.G. Cowie, Polymers: Chemistry and Physics of Modern Materials, Blackie, London, 1991.
4. R.J. Young and P.Lovell, Introduction to Polymers, 2nd Ed., Chapman & Hall, 1991.
5. Premamoy Ghosh, Polymer Science and Technology of Plastics and Rubbers, Tata McGraw - Hill, New Delhi, 1990.
6. H.R. Allcock and F.W. Lampe, "Contemporary Polymer Chemistry", Prentice Hall 1981.
7. F.W.Billmeyer, " Text Book of Polymer Science", Wiley Interscience, 1971.
8. F.Rodrigues, " Principles of Polymer systems", Mc Graw Hill, 1970

PO010 304: **Computer Programming**

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

Objectives

- *To provide the basic concepts of computer hardware and software*
- *To generate C programming concept among the students*

Module 1 (12 hours)
Computer fundamentals, classification, mainframe, mini and microcomputers, block schematic of personal computers. Concept of software and hardware, concept of operating systems. Programming languages, classification, machine language, assembly language and

high level language. Program development, flow charts and algorithms. Compilers, assemblers

Module 2 (15 hours)
C Programming, Introduction to C programming language, compilation of C programs. Structure of a C program, input/output statements, fundamental data types, variables, identifiers, keywords, operator precedence and associativity, arithmetic expressions. Loop statements-for, while, do-while. Decision statements-if, nested if, switch statements, break and continue statements, example for a simple C program

Module 3 (15 hours)
Arrays and structures: single and multidimensional arrays, character arrays and its initializations. String and its initializations. Declaration and initialisation of structure variables, array of structures and nested structures. Example programs using structures, unions

Module 4 (8 hours)
Functions-concept, function declaration and calling, arguments and local variables, parameter passing methods in C function, array passing in C function. Concept of recursive functions

Module 5 (10 hours)
Pointers and files: declaration, passing pointers to a function, accessing array elements using pointers, operation on pointers. Opening and closing a file, creating and processing a file

References

1. Programming in C : E Balaguruswamy
2. Let us C : Y.P.Kannetkar
3. Pointers in C : Y.P.Kannetkar
4. Programming with C : Bryan.S.Gottfried,Tata McGrawHill

PO010 305: **Organic Chemistry**

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

Objective

- *To familiarize the organic reaction mechanisms and spectroscopic methods*

Module 1 (10 hours)
Chemical bonding and molecular structure, electronic effects in organic molecules, inductive, mesomeric and hyperconjugation effects, acids and bases, reactive intermediates in organic chemistry- carbocations, carbanions, free radicals, carbenes and nitrenes.

Module 2 (15 hours)
Organic reaction mechanisms, introduction. Substitution and Elimination reactions: detailed study of SN_1, SN_2, SN_i, SN_1', SN_2' and borderline mechanisms. Nucleophilicity and basicity, leaving group effects, solvent effects, neighboring group participation. Detailed study of elimination reactions (E_1, E_2, and E1cb mechanisms), substitution vs. elimination.

Module 3 (10 hours)

Rearrangement Reactions: common rearrangements in organic chemistry, rearrangement of carbocations, non-classical carbocations. Catalysis by acid & bases, Lewis acid catalysis, Phase transfer catalysis and applications of crown ethers. Methods of determination of organic reaction mechanisms.

Module 4 (15 hours)
Isomerism of organic compounds: isomerism, definition and classification, molecular representation, stereo isomerism, conformation, configuration, chirality and optical activity, stereocentre, racemisation and methods of resolution, chiral synthesis, optical purity and enantiomeric excess, configurational nomenclature, D, L, R and S, determination of configuration, geometrical isomerism, E/Z notation, interconversion of geometrical isomers, conformational analysis of acyclic and cyclic molecules, rotation about bonds, concepts of dihedral angle, torsional strain, optical rotatory dispersion and circular dichroism.

Module 5 (10 hours)
Organic Spectroscopy: principles and applications of UV, IR, NMR, ESR spectroscopic techniques for the structure elucidation of organic compounds, problem solving approach. Recent advances in NMR techniques, 13C–NMR, 2 dimensional NMR spectroscopy.

References

1. Morrison & Boyd, Organic Chemistry, Prentice Hall. New Delhi, 6th edition,1992
2. B.S.Bahl and Arun Bhal, Advanced Organic Chemistry, S. Chand & Co. Ltd., New Delhi, 15th edition, 1998
3. I.L.Finar, Textbook of Organic Chemistry, ELBS, 5th edition, 1996
4. Jerry March, Advanced Organic Chemistry, John Wiley & Sons, New york, 1992

PO010 306(CE) Strength of Materials & Structural Engineering

(Common with ME010 306(CE), AU010 306(CE) and PE010 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,Sth 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.

PO010 307: **Chemistry Lab**

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

Objective

- *To create skills in organic synthesis and skills in analytical methods*

A. Organic synthesis

1. Synthesis of ethyl n- butyl acetoacetate by the acetoacetic ester condensation
2. Synthesis of 3-nitrobenzoic acid from benzoic acid
3. Nitration of aromatic hydrocarbons.
4. Side chain oxidation of aromatic hydrocarbons.
5. Benzoylation of phenols.
6. Preparation of solid esters.
7. Bromination of amines.

B. Purification and characterization of organic compounds

1. Purification (fractional crystallization, fractional distillation, chromatography) and separation of the components of a binary organic mixture (liquid-liquid, liquid-solid and solid-solid) using chemical analysis and IR and NMR spectral data.
2. Identify the components of the given binary mixture.
3. Checking the purity of the separated components on TLC plates.

PO010 308: **Computer Lab**

Teaching scheme **Credits:** 2

3 hours practical per week

1. Familiarisation of DOS commands and WINDOWS.
2. Simple C programs with control statements and loops.
3. Programs handling one-dimensional array.
4. Programs handling multidimensional array
5. Programs using a simple function.
6. Functions having arguments.
7. Recursive functions.
8. Programs handling structures.
9. Programs using pointers.
10. Programs involving files.
11. A simple graphic program.

EN010 401: Engineering Mathematics III

(Common to all branches)

Teaching scheme **Credits: 4**

2 hours lecture and 2 hour tutorial per week

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

References

1. Bali& Iyengar – A text books of Engg. Mathematics – Laxmi Publications Ltd.
2. M.K. Venkataraman – Engg. Mathematics vol II 3rd year part A & B – National Publishing Co.
3. I.N. Sneddon – Elements of partial differential equations – Mc Graw Hill
4. B.V. Ramana – Higher Engg. Mathematics – Mc Graw Hill
5. Richard A Johnson – Miller Fread's probability & Statistics for Engineers- Pearson/ PHI
6. T. Veerarajan – Engg. Mathematics – Mc Graw Hill
7. G. Haribaskaran – Probability, Queueing theory and reliability Engg. – Laxmi Publications
8. V. Sundarapandian - probability ,Statistics and Queueing theory – PHI
9. H.C.Taneja – Advanced Engg. Mathematics Vol II – I.K.International
10. A.K.Mukhopadhyay-Mathematical Methods For Engineers and Physicists- I.K.International

EN010 402(ME): PRINCIPLES OF MANAGEMENT

(COMMON WITH EN010 502(ME))

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

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

Module I (12 hours)

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

Module II (12 hours)

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

Module III (12 hours)

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

Module IV (12 hours)

Financial Management: Objectives and Functions of Financial Management- Types of Capital- Factors affecting working capital- Methods of financing.

Cost Management: Elements of cost- Components of cost- Selling Price of a product.

Module V (12 hours)

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

Text Books

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

Reference Books

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

PO010 403: **Polymer Physics**

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

Objectives

- *To impart the concept on polymeric deformation*
- *To impart the awareness on rheological properties*

Module 1 (10 hours)
Stress- engineering stress, true stress. Strain- engineering strain, true strain. Modulus- Young's modulus, compression modulus, bulk modulus. Compliance, Poisson's ratio, elastic solid, Hooke's Law, viscous fluid, Newton's law, viscoelastic materials, difference in the response of elastic solid, viscous fluid and viscoelastic materials under static and dynamic conditions, factors affecting viscoelasticity

Module 2 (15 hours)
Short-term properties, Long-term properties-creep, stress relaxation. stress- strain curves, hysteresis, tangent modulus, secant modulus, proportionality limit, Mechanical models- spring, dashpot, Maxwell and Voigt models, Generalised equations for Maxwell and Voigt models, Equations for Maxwell and Voigt models under creep and stress relaxation situations, Maxwell-Weichert model, Burger model, Deborah number

Module 3 (10 hours)
Time-temperature equivalence principle, Boltzmann superposition principle, simple numerical problems based on Boltzmann superposition principle. Dynamic mechanical properties- storage modulus, loss modulus, tan δ, damping

Module 4 (10 hours)
Rubber elasticity, molecular requirements of rubber-like elasticity, energy driven elasticity, entropy driven elasticity, thermoelastic experiment, Gough-Joule effect, thermodynamics of rubber elasticity

Module 5 (15 hours)
Newtonian fluids and non-Newtonian fluids, Power law, shear rate dependent fluids- psuedoplasticity, dilatancy. Time dependent fluids- thixotropy, rheopexy. Rheological measurements- plasticity retention index, oscillating disc rheometer: curing characteristics, scorch time, induction time, cure time, capillary rheometer: entrance effect, Rabinowitsch correction, cone and plate viscometer, Mooney viscometer, melt flow index. Elastic effects in polymer melt flow- die swell, elastic turbulence, melt fracture, shark skin, draw down

References

1. David J. Williams, Polymer Science and Engineering, Maclaren and Sons, Newyork1978
2. H.F. Haufman and J.J. Falcetta, Introduction to Polymer science and Technology, S P E Text Book, John Wiley & Sons New York 1997
3. J. D. Ferry, Viscoelastic Properties of Polymers, John Wiley & Sons NewYork 1971
4. R.J.Samuels, Structured Polymer Properties, John Wiley & Sons, New York, 1974.
5. J. A. Brydson, Flow Properties of Polymer Melts

PO010 404: **Polymer Science - II**

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objective

- *To impart the basic knowledge in structure-property relationship of polymers*

Module 1 (10 hours)

Amorphous state, molecular motion, first order and second order transitions, T_g, T_m, factors affecting T_g, secondary transitions, free volume, kinetic, and thermodynamic views of glass transition, factors influencing glass transition temperature

Module 2 (10 hours)

Crystalline state, crystal systems, unit cells, primitive cell, Bravais lattices, polymorphism, polymer single crystals, lamellae, spherulites, supermolecular structures, fringed micelle model, degree of crystallinity, factors affecting crystallinity, X-ray diffraction, copolymers, linear and cyclic arrangement.

Module 3 (15 hours)

Polymer solutions, terms and definitions, types of solutions, Hildebrand approach, Flory Huggins theory, thermodynamic view of miscibility, upper critical solution temperature (UCST), lower critical solution temperature (LCST), concentration regimes in polymer solutions, theta conditions.

Module 4 (15 hours)

Chemical reactivity of linear and crosslinked polymers, hydrolysis, acidolysis, aminolysis, hydrogenation, addition and substitution reactions, cross linking reactions, reactivity of functional groups, polymer analogous reactions, polymer bound reagents, chain end and random degradation, degradation by oxygen, ozone, heat, UV light, micro-organism, crazing, weathering, stabilisation to prevent degradation.

Module 5 (10 hours)

Effect of polymer structure on dielectric constant, capacitance, dielectric loss, power factor, dissipation factor and loss factor, prediction of molar polarization and effective dipole moment, effect of additives on electrical properties of polymers, effect of polymer structure on optical properties, clarity, transparency, haze, transmittance, reflectance, gloss, prediction of refractive indices of polymers by group contributions.

References

1. Paul C. Painter and Michael M. Coleman, Fundamentals of Polymer Science, Technomic Publishing Co. Inc., Lancaster, USA, 1994.
2. Ulf W. Gedde, Polymer Physics, Chapman & Hall, 1995.
3. D.W. Van Krevelen And P.J. Hoftyzen, "Properties Of Polymer, 3rd Edition Elsevier Scientific Publishing Company Amsterdam – Oxford – Newyork. 1990
4. J.E. Mark Ed.AIP, Physical Properties Of Polymers Hand Book, Williston, Vt, 1996.
5. D.A.Seanor, ed., Electrical properties of polymers, Acadamic press, Newyork, 1982.
6. Jozef.Bicerano, Prediction Of Polymer Properties, Second Edition, Marcel Dekker Inc. Newyork, 1995.
7. I.M.Ward & D.W.Hadley, An Introduction to the Mechanical Properties of Solid Polymers, John Wiley & Sons, Chichester, England, 1993.

PO010 405: **Chemical Engineering - I**

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

Objectives

- *To create basic concepts of chemical engineering and fluids*

Module 1 (10 hours)
Introduction, units, concept of atomic weight, equivalent weight and moles, composition of solids- weight percent and mole percent, composition of liquids and solutions, concentration, molarity and normality, pH, specific gravity scales, gas constant, gaseous mixtures, ideal gas law, van Der Waal's equation, Dalton's law, Amagat's law, average molecular weight and density, critical properties

Module 2 (15 hours)
Material balance without chemical reactions- introduction, key component, recycling and bypass operations, purging, steady and unsteady state operations, material balance problems involving mixing, leaching, evaporation, distillation and absorption. **Material balance with chemical reactions**- definition of terms, limiting reactant, excess reactants, percentage yield, degree of completion- typical problems

Module 3 (10 hours)
Properties and nature of fluids, ideal fluid, real fluid, density, specific weight, specific volume, surface tension, compressibility, capillarity, absolute and gauge pressures, fluid statics, hydrostatic equilibrium, Pascal's law, measurement of pressure using manometer, U-tube manometer, differential manometer, inverted manometer, micro manometer

Module 4 (15 hours)
Fluid flow phenomena, flow of incompressible fluid, classification of flow, steady and unsteady state flow, uniform and non uniform flow, one, two, and three dimensional flow, Newtonian and non-Newtonian fluids, viscosity, momentum flux, Reynolds experiment, laminar and turbulent flow, turbulence, nature of turbulence, flow in boundary layers, boundary layer separation, isothermal and adiabatic flow, temperature lapse rate, barometric equation

Module 5 (10 hours)
Equation of continuity, Euler equation, Bernoulli's theorem, correction factors, friction factor, Hagen Poisuille equation, velocity distribution for laminar flow, velocity distribution for turbulent flow, measurement of fluid flow, pitot tube, orificemeter, venturimeter, rotameter

References

1. Mc Cabe and J.M Smith, *Unit Operations in Chemical Engineering*, McGraw-Hill publishing company, New Delhi
2. Streeter, *Fluid Mechanics*,
3. Jagadish Lal, *Fluid Mechanics*,
4. P.N Modi, *Hydraulics and Fluid mechanics*,
5. Stochiometry, Tata McGraw Hill Company limited, New Delhi, Bhatt & Vora

PO010 406: **Electrical Technology**

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

Objectives

- *To provide an overview of electrical machines and its applications*

Module 1 (12 hours)
Basic Principles of Electric Machines- concept of motoring and generating action, DC generator, characteristics, working, load test, DC motor, characteristics,, load test, speed control, field control, armature control, basic principles, applications.

Module 2 (15 hours)
Transformers: Transformer action, EMF equation, step up and step down transformer, load test, calculation of efficiency, design of typical step down transformers like 280/6-0-6V, 230/9-0-9 V, 280/12-0-12 V for inverters and rectifiers. Auto and three phase transformers, basic principles of current transformers (no analysis) basic principles of servo stabilizer.

Module 3 (11 hours)
A C Machines; Basic principles of operation of synchronous and induction motor characteristics (no analysis), starting of induction motors, starters, single phase induction motor, constructional features, types, working and characteristics only (no analysis).

Module 4 (11 hours)
Special Machines AC&DC servo motors, synchros constructional features, working of tacho generators, stepper motor, construction working, applications& specifications of stepper motors, universal motors, constructional features, typical applications, criteria for selection of motors, electromagnetic relays, AC&DC contactors.

Module 5 (11 hours)
Batteries: Dry cells, secondary cells, lead acid cells, charging and discharging characteristics, Ampere hour rating of batteries, construction of button cells, lithium batteries, specifications chargeable batteries, battery charging circuits, Maintenance of batteries, characteristics of nickel cadmium, nickel metal hydride, and lithium ion batteries, used for pagers and cellular phones, concept of UPS, block schematic of UPS, fields of applications.

References

1. Electrical Technology -B.L.Thereja
2. Electrical Machines -R.K. Rajput
3. Electrical Design Estimating And Costing -K.B. Raina & Bhattacharya
4. Electrical machines and Power systems -Vincent Del Toro
5. Electric Engineers Hand Book -Donald G. Fink

PO010 407: **Polymer Preparation & Characterisation Lab**

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

Objective

- *To familiarise the students about various polymer preparation and monomer characterisation methods*

1. Synthesis of the following Polymers: Polymethyl methacrylate, Polyacrylamide, Regenerated Cellulose, Phenol-Formaldehyde Resin (Novolac and Resol), Polystyrene, Polyurethanes and Glyptal resins, Urea-Formaldehyde and Melamine-Formaldehyde.
2. Quantitative estimation of the following monomers: Aniline, Phenol, Acetone, Ethyl Acetate, Formaldehyde, Acrylonitrile, Urea, Glycol, Methyl methacrylate
3. Determination of molecular weight by viscosity method.
4. Estimation of Polymers: Acrylonitrile content of NBR, Chlorine content of CR, Rubber hydrocarbon content of NR.
5. Analysis of Polymer Compounds: Iodine value of rubber compounds, Carbon black content, Free sulphur content, Total inorganic content, Silica content.

PO010 408: **Electrical Machines Lab**

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

Objective

- *To impart practical knowledge on electrical & electronic machines and parts*

A total of 8 experiments (4 from Group A and 4 from Group B) out of 16 suggested below shall be done in the laboratory.

GROUP A

1. O.C.C and Load test on DC generator.
2. Load test on DC shunt motor.
3. Load test on Single phase induction motor.
4. Load test on 3-phase cage induction motor.
5. Load test on 3-phase slip ring induction motor.
6. Load test on single phase transformer.
7. Load test on 3-phase alternator – regulation at different power factor –
8. Demonstration of terminal voltage control.

GROUP B

1. Characteristics of diode and Zener diode.
2. Half-wave and full-wave rectifier – study of wave forms and regulations.
3. Transistor biasing – assemble CE amplifier – study input and output
4. Waveforms.
5. Assemble RC phase shift oscillator – study waveforms.
6. Study of SCR – assemble single phase controlled rectifier – study phase control.
7. Operational amplifier circuit – adder, integrator.
8. Study of logic gates – AND, OR, INVERTER, NAND, NOR, Half adder and full adder using NAND gates.

EN010 501A: ENGINEERING MATHEMATICS IV

(Common to all branches except CS & IT)

Teaching scheme **Credits: 4**

2 hours lecture and 2 hour tutorial per week

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

MODULE 1 Function of Complex variable (12 hours)

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

MODULE 2 Complex integration (12 hours)

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

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

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

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

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

MODULE 5 Linear programming problem (16 hours)

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

References

1. B.V. Ramana – Higher Engg. Mathematics – Mc Graw Hill
2. M.R.Spicgel , S.Lipschutz , John J. Schiller, D.Spellman – Complex variables, schanm's outline series - Mc Graw Hill
3. S.Bathul – text book of Engg.Mathematics – Special functions and complex variables –PHI
4. B.S. Grewal – Numerical methods in Engg. and science - Khanna Publishers
5. Dr.M.K Venkataraman- Numerical methods in science and Engg -National publishing co
6. S.S Sastry - Introductory methods of Numerical Analysis -PHI
7. P.K.Gupta and D.S. Hira – Operations Research – S.Chand
8. Panneer Selvam– Operations Research – PHI
9. H.C.Taneja – Advanced Engg. Mathematics Vol II – I.K.International

PO010 502: **Plastics - Science & Technology**

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

Objectives

- *To create concept on various plastic materials, their synthesis and applications*

Module 1 (10 hours)
Advantages and disadvantages of plastics, monomer preparation, polymerisation, properties and application of LDPE, HDPE, cross linked and chlorinated PE, PP and PS

Module 2 (15 hours)
Monomer preparation, polymerisation, properties and application of PVC, polyvinilidine chloride, PVA, polyvinyl acetate, PMMA and PAN

Module 3 (15 hours)
Monomer preparation, polymerisation, properties and application of PU, PTFE, PVF, ABS, PC, polyacetal, polyester, SAN, epoxies

Module 4 (10 hours)
Monomer preparation, polymerisation, properties and application of nylon-5, 6, 66, 612 and polyacrylamide

Module 5 (10 hours)
Monomer preparation, polymerisation, properties and application of PF, novolac, resol, MF and UF resins

References

1. K.J. Saunders, "Organic Polymer Chemistry, Chapman and Hall ", London.1973.
2. J.A. Brydson, " Plastic materials", Newnes Butterworths.
3. Encyclopaedia of Polymer Science and Technology.

PO010503: **Polymer Processing - I**

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

Objectives

- *To familiarize various compounding ingredients and mixing equipments*

Module 1 (7 hours)
Compounding ingredients, stabilizers, fillers, antioxidants, antiozonants, UV absorbers, flame retardants, peptiser, retarder, curing agents

Module 2 (8 hours)
Compounding ingredients, plasticisers, process aids, extenders, factice, mould release agents, tackifying agents, blowing agents, bonding agents, fragrances, antistatic agents, colorants, and other special additives

Module 3 (15 hours)
Compound development, factors to be considered for compound development, formulation of a mix, compounding for specific applications, ozone resistance, heat resistance, weather,

resistance, oil resistance, radiation resistance, permeability, medical, liquid resistance, low temperature resistance, electrical applications and optical applications

Module 4 (15 hours)
Compounding, different methods, principles of mixing, dispersive and distributive mixing, mastication, two-roll mill mixing, internal mixers, comparison between open mill and internal mixer, Banbury mixing, Brabender plasticorder, continuous mixing, master batching.

Module 5 (15 hours)
Processing techniques, compression moulding, types-flash, positive and semipositive, compression moulding cycle, troubleshooting, moulding of thermosets and rubber, automatic compression moulding. Transfer moulding, transfer moulding cycle, advantages, limitations, theoretical and design consideration, general mould design consideration, troubleshooting.

References

1. D.V. Rosato Kluwer, Injection moulding hand book. - Academic Publishers Boston 2nd edtion 1995.
2. Richard C. Progelhof James. L. Throne, Polymer Engg. Principles, Hanser Publisher Munich 1993
3. N.P. Charemisinoff & P.N. Chere, Hand book of applied Polymer Processing Tech, Marcel Dekker, inc, NY 1996.
4. Herbert Recs, Understanding of Injection moulding Tech., Hanser Pub., Munich 1994.

PO010 504: **Chemical Engineering - II**

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

Objective

- *To create knowledge on heat transfer*

Module 1 (10 hours)
Modes of heat transfer, conduction and Fourier law, thermal conductivity, steady state conduction through single resistance and compound resistances in series, heat flow through rectangular, cylindrical and spherical systems, critical and optimum thickness of insulation, general heat diffusion equation, derivation, Poisson's equation, Laplace equation, equation for one dimensional conduction.

Module 2 (8 hours)
Transient conduction, lumped capacitance method, validity of lumped capacitance analysis with all boundary surfaces subjected to convection, part of the boundary under convection, boundary condition and other part with prescribed heat flux condition, significance of biot number and Fourier number, concept of thermal diffusivity, fins - types, longitudinal and transverse, fin efficiency

Module 3 (20 hours)
Convection boundary layer, velocity and thermal boundary layer, concept of individual and overall heat transfer coefficients, **forced convection**- evaluation of forced convection heat transfer coefficients using dimensional analysis, Buckingham π theorem, empirical correlation for forced convection heat transfer for external and internal flows under laminar and turbulent conditions, *internal laminar flow* - thermally and hydraulically developed flows, simultaneously developing laminar internal flow situations for both constant heat flux and wall temperature conditions, *external laminar flow*- empirical correlation for heat transfer for

flow over flat plates and other geometries, correlation for forced convection heat transfer for external and internal flows under turbulent conditions, concept of reference temperatures, analogy between heat and momentum transfer - Reynolds's and Colburn analogy, significance of Prandtl number, number, Peclet number, Nusselt number, Sieder Tate equation, Coulburn equation, **natural convection** - principles, evaluation of natural convection heat transfer coefficient using dimensional analysis, empirical correlation for natural convection heat transfer from vertical and horizontal planes and cylinders under isothermal and constant heat flux conditions

Module 4 (12 hours)
Classification of heat exchangers, concept of overall heat transfer coefficient, derivation of expression, concept of fouling factors, determination of overall heat transfer coefficient with and without fouling, concept of logarithmic mean temperature difference and its correction factor, temperature-distance plots for different flow arrangements, determination of area, length, number of tubes required for a given duty in different configurations using LMTD method, 1-1 shell and tube heat exchangers, 1-2 exchanger, 2-4 exchanger, constructions, double pipe heat exchangers, construction, various steps for the design

Module 5 (10 hours)
Evaporation, types of evaporators, construction and operation, natural circulation, forced circulation, falling film, climbing or rising film evaporators, agitated thin film evaporators, plate evaporators, single effect evaporators, enthalpy balance, multiple effect evaporators, methods of feeding, capacity, economy, boiling point elevation, Duhring's rule, calculation of heat transfer area

References

1. Mc Cabe and J.M Smith, *Unit Operations in Chemical Engineering*, McGraw-Hill publishing company, New Delhi
2. Badger, *Introduction to Chemical Engineering*, Tata McGraw-Hill, New Delhi
3. Mc Dams, *Heat transmission*, Tata McGraw- Hill, New Delhi,
4. Binay K.Dutta, *Heat Transfer- Principles and Applications*, Prentice Hall of India, New Delhi,
5. Incropera and Dewit, *Fundamentals of Heat and Mass Transfer*, McGraw- Hill,

PO010 505: **Latex Technology**

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

Objective

- *To impart knowledge on processing and product development of polymer latices*

Module 1 (8 hours)
Natural latex, preservation, Fundamental latex characteristics, particle size and distribution, stability and destabilisation, coacervation, viscosity-concentration relationship, surface free energy and wetting behaviour, zeta potential, electrical properties of colloidal system, thermal movement of molecules, Brownian motion, synthetic lattices and their blends

Module 2 (12 hours)
Latex concentration methods, concentrated latex, significance of specification limits, test methods, total solids, dry rubber content, total alkalinity, coagulum content, sludge content, pH, KOH number, mechanical stability time, VFA number, surface tension, redox potential changes, degradation leading to acid formation, zinc oxide stability, stability tests, volatile fatty acids.

Module 3 (10 hours)
Principles of latex compounding, deammoniation of latex, vulcanising agents, accelerators, antioxidants, fillers, dispersing and emulsifying agents, stabilisers, thickening agents, and other miscellaneous additives, special ingredients, preparation of dispersions and emulsions, latex compounding.

Module 4 (15 hours)
Manufacture of rubber goods from latices and from solid elastomers, a comparison, impregnation, spreading, fabric proofing and coating. Rubber textile composite products, latex bonded fibrous structures, coir foam, latex treated rugs and carpet backing, latex application to paper. Dipping Methods, straight dipping, dipping with porous formers, coagulant dipping, heated formers, drying, surface treatments, extraction of surface soluble materials, vulcanisation, compounding of latex, manufacture of dipped goods like rubber band, surgeons gloves, household gloves, dipped fabric gloves, balloon, nipples, prophylactics.

Module 5 (15 hours)
Latex foam processing methods, ammonia content of latex, compounding, mechanical frothing by beating, vulcanisation, washing, and drying, gelling, gelling systems, merits and demerits of gelling systems, continuous foam production, typical latex compounds for foam production, latex casting, principles, production of hollow articles, solid articles, use of porous moulds in casting, manufacture of rubber thread, latex cement and adhesives, latex paints, protective coatings, chewing gum, use of latex in road rubberisation.

References

1. D. C. Blackley, High Polymer Latices, Vol I&II, Maclaren & Sons, London
2. Madge, Latex Foam Rubber, Maclaren & Sons Ltd; 1982
3. Mausser, Vanderblit Latex Handbook, 3rd edition, Pub.R.T.Vanderbilt Co. Inc., U.S.A. 1987
4. Dipped goods, J. of Rubber Developments, V 25, pp.12-14-1972

PO010 506: **Rubbers - Science & Technology**

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

Objective

- *To impart knowledge on structure, properties and production of natural and synthetic rubbers*

Module 1 (10 hours)
Natural rubber, source, chemical formula, molecular weight distribution, crystallisation, structure property relationship, chemical reactivity, electrical and oxidation properties, anti degradants, strength of rubbers, Various forms of natural rubber- crumb, sheet, crepe, SP rubber, DPNR, LNR, liquid rubber, classes of liquid elastomers, telechilic polymers, powdered rubber

Module 2 (15 hours)
Vulcanisation, chemical and physical aspects, curing characteristics such as scorch time, induction time, cure time, activators, accelerators, promoters, Mechanism of crosslinking by different crosslinking agents- sulphur, sulphur monochloride, nitrosourethane, diazo esters, phenolic resins, metal oxide, diamines, peroxides, oximes, different curing systems, EV, semi

EV, conventional and sulphur less cure, assessment of state of cure, Vulcanisation techniques, batch and continuous vulcanization: press cure, autoclave, hot air, cold and hot water, fluidised bed, molten salt bath, drum curing, radiation, microwave curing

Module 3 (15 hours)
IR, BR, IIR, SBR, -synthesis of monomers, polymerisation, structure, chemical properties, crosslinking by different methods, oxidation and ageing, halogenation of IIR, characterization and crosslinking

Module 4 (10 hours)
Monomer preparation, polymerization, structure, crosslinking by different methods, properties and application of NBR, CR, PU, silicone and EP rubbers, Comparison of the oxidation properties of saturated and unsaturated rubbers, antioxidants, antiozonants,

Module 5 (10 hours)
Monomer preparation, polymerization, structure, properties and application of the following rubbers- chlorosulphonated polymers, fluorine containing rubbers, nitrosofluoro elastomers, phosphonitrillic elastomers, poly(thiocarbonyl fluoride) and related elastomers, acrylic rubbers, poly (vinyl ether) elastomers, polysulphide rubber, polyalkenamers, polynorbornene, thermoplastic rubbers, polycarbonate rubbers

References

1. J.A. Brydson, Rubber Chemistry, allied Science publishers, London, 1978.
2. M.Morton, Rubber Technology, Van Nostrand Reinhold, 1987.
3. J.A. Brydson, Rubber Materials and Their Compounds Elsevier, 1988.
4. A.Whelan and K.S. Lee, Developments in Rubber Technology (Vol. I-IV) Applied Science Publishers.

PO010 507: **Specification Tests Lab**

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

Objective

- *To create practical knowledge on specification tests for latex and dry rubber*

1. Specification tests for field latex
   Viscosity, density, pH
2. Specification tests for preserved latex
   Ammonia content, Magnesium content, Copper and manganese content, Dry rubber content, Total solid content, KOH number, Volatile fatty acid number, Sludge content, Coagulum content, Mechanical stability time, Heat stability time, ZnO stability.
3. Specification tests for dry rubber
   Volatile matter, Ash content, Dirt content, Nitrogen content, Estimation of Cu, Estimation of Fe, Estimation of Mn, P_0, PRI.

PO010 508: **Polymer Analysis Lab**

Teaching scheme **Credits:** 2

3 hours practical per week

Objective

- *To familiarise the analysis of polymers and polymer compounds*

1. Identification of Rubbers: NR, SBR, BR, IR, IIR, EPDM, CR, NBR, Hypalon, Thiokol, Silicone.
2. Identification of Plastics: PE, PP, PS, PVC, PVA, PF, UF, MF, Polyester.
3. Identification of Thermoplastic Elastomers: SIS, SBS, SEBS, Hytrel.

PO010 601: **Engineering Statistics & Quality Control**

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

Objective

- *To provide knowledge on scientific methods of quality control*

Module 1 (8 hours)
Population and sampling, large and small samples, random sampling, stratified sampling, estimating the mean and variance, confidence intervals, choice of sample size for estimation. Testing of hypotheses for large samples, means, proportions, difference of means and standard deviations. Testing of hypothesis for small samples, t-distribution, test of hypothesis for mean, difference of means, test for paired data, F-distribution, f-tests and properties, contingency table, χ^2 distribution, goodness of fit and independence of attributes

Module 2 (12 hours)
Meaning of quality, variables and attributes data, benefits of control charts, control charts for variables, check list for $\bar{x}$ and R charts, calculation of 3-sigma limits for $\bar{x}$, control charts for range, OC curve for $\bar{x}$ chart, OC curve for R chart, average run length (ARL) for the $\bar{x}$ chart

Module 3 (15 hours)
Control charts for fraction rejected, control chart for attributes, control limit for the p-chart, control chart for non-conformities, c-chart in statistical process control, applications of c-chart, limits for c-chart, Q-chart for quality scores, D-chart for demerit classification

Module 4 (15 hours)
Acceptance sample, types of acceptance, sampling plans, determination of probability of acceptance by these sampling plans, sampling risks, design of sampling for stipulated producers risk and consumers risk. Concepts of AQL, LTPD, AOQL in sampling, QC curves, construction, standard sampling plans, MIL, STD, LOSD, plan, Dodge-Roming (D-R) sampling plans, continuous and sequential sampling plans.

Module 5 (10 hours)
Definition of reliability, maintainability, failure rate, mean time between failures, factors contributing to reliability of products, failure cycle of products, bathtub curve, reliability tests, operating characteristics, curves for acceptance.

References

1. R.C.Gupta, Statical Quality Control, Khanna Publishers, 8th edition, Delhi, 2008
2. I.W.Burr, Engineering Statics and Quality Control, Mc-Graw Hill, 1975
3. A.J.Duncon, Quality Control and Industrial Statistics, Richard. Irwin, Inc., 1975
4. Granth and Leavenworth, Statistical Quality Control, TMH, 7th edition, 1996
5. Sigmund Halpern, An Introduction to Quality Control and Reliability,
6. Quality Control Handbook (TMH)
7. Gupta and Kapoor, Fundamentals of Mathematical Statistics.

PO010 602: **Polymer Processing - II**

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

Objective

- *To create awareness on various techniques used in polymer product manufacturing*

Module 1 (15 hours)
Injection moulding, terminology, process description, moulding cycle, classification of moulds, 2-plate and 3-plate moulds, different types of gates, cavity lay-out, setting up of mould, types of injection unit, elements of plasticating process, classification of screw, screw design, process control, clamping unit, classification of machine hydraulics, ancillary equipment, computer operation, trouble shooting of injection moulding, reaction injection moulding

Module 2 (15 hours)
Extrusion, principle, types of extruders, single screw and twin-screw extruders, metering, screw design, process control variables, types of dies, die design, elastic properties and die swell, manufacturing of pipes, cables, wire coating, extrusion profiles, blown films, flat film, sheets, filaments, lamination, extrusion of elastomers

Module 3 (10 hours)
Blow moulding, terminology, basis, process variables, injection & stretch blow moulding, single and multi layer, extrusion blow moulding, extrusion heads, process controls for blow moulding machine, process and product controls, trouble shooting in blow moulding

Module 4 (10 hours)
Thermoforming, definition, methods of forming, thermoforming machinery, heating of sheet, heating cycle, stretching, concept, hot strength, blistering, sags, cooling and trimming the parts, heat balance, shrinkage, trimming operations, finishing and machining of plastics, joining, welding and assembling of plastics

Module 5 (10 hours)
Rotational moulding, types of machines, moulds, materials, part design, calendering, types of calenders and strainer, embosser, winder, take off-systems, crowning, machinery powder coating, manufacturing methods, application methods, types of powder coating,

References

1. Edited by Michael L. Berlin Plastics Engineering. Handbook. Society of the plastic Industries Chapman & Hall NY 1991.
2. James L. Throne, Technology of Thermoforming. Hanser, Publisher Munmich 1996.
3. M.J. Stevens and J.A. Covas, Extruder principle and operation. Chapman & Hall UK, 2nd edtion 1995.
4. D.V. Rosato & D.V. Rosato, Blow moulding Hand book, Hanser Published 1998.

PO010 603: **Industrial Engineering**

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

Objective

- *To generate basic concepts of industrial engineering*

Module 1 (15 hours)
Introduction, evolution of modern concepts, functions of an industrial engineer, field of application, entrepreneurship, concept of project, types of investment, capital budgeting, investment proposals, project development cycle, preinvestment analysis, project environments, government regulations, import-export status, foreign exchange regulations, technical collaborations, means of raising capital, availability of resources, marketing survey and strategies.

Module 2 (10 hours)
Selection of factory site, building design, construction, plant layout and material handling, product and process, layout, comparison of flowchart, use of time study data, physical facilities, constructional details, environmental control like lighting, temperature, humidity, ventilation, noise, dust, industrial waste disposal-principles of material handling, types of material handling equipment, selection and application.

Module 3 (10 hours)
Product development and research, design function, objectives of design, manufacture Vs purchase, development of design, experimentation, prototype production, testing, simplification, standardization, product development, selection of materials and processes, human factors in design, value engineering

Module 4 (10 hours)
Maintenance and replacement, preventive and breakdown maintenance, economic aspect, replacement of equipment, methods of providing for depreciation, determination of economic life, criteria for selection of equipment

Module 5 (15 hours)
Methods Engineering, analysis of work methods using different types of process charts and flow diagrams, critical examination, micro motion study and Therblings, SIMO chart, principles of motion economy, determination of standard time and allowances, accounting and costing, element of double entry book keeping, trial balance, trading profit and loss account, balance sheet, principles of costing, methods of allocation of overhead costs, finance and capital requirements, price fixation, cash flow statements, return of investment, source of finance

References

1. Production System - J.L.Riggs
2. Production Control - Hiegel
3. Human Factors in Engg. Design - Mc Cornic, E.J.
4. Time and Motion Study - Barnes R.M.
5. Operations Management - Buffa E.S.
6. Value Engineering - Miles L.D.
7. Methods Engineering -Krick
8. System Analysis and Project Management -Cleand &king.

PO010 604: **Chemical Engineering – III**

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

Objective

- *To develop knowledge on mass transfer*

Module 1 (10 hours)
Molecular diffusion, molecular diffusion in gases and liquids, Fick's law, mass transfer coefficient, steady state diffusion of A through stagnant B and equimolar counter diffusion in binary gases and liquids, diffusivity of liquids and gases. Applications of molecular diffusion, mass, heat and momentum transfer analogies.

Module 2 (10 hours)
Distillation, vapour-liquid equilibrium, Dalton's law, Raoult's law and Henry's law, relative volatility, boiling-point diagrams, equilibrium diagrams, rectification, simple distillation, flash distillation, Rayleigh equation, derivation and problems

Module 3 (10 hours)
Construction of fractionating column, calculation of the number of theoretical plates by Mc-Cabe Thiele method, feed quality and feed line, feed plate location, total reflux, minimum reflux, optimum reflux, plate efficiency – overall, local, murphree efficiency

Module 4 (15 hours)
Drying, principles of drying, heat transfer in drying, mass transfer in drying, equilibrium moisture content, bound, unbound and free moisture, critical moisture content, batch drying, rate of batch drying, constant drying rate period, factors affecting the constant drying rate period, falling rate period, time of drying, rate of drying curve, material and enthalpy balances in drying, equipments for drying, batch dryers, rotary dryers, tunnel dryers.

Module 5 (15 hours)
Gas absorption, absorption equipment, tray towers, continuous contact equipment, packed columns, properties of tower packing, types of tower packing, tower construction, solubility of gas in liquid, two component systems, ideal liquid solutions, non ideal liquid solutions, choice of solvent, material balance in absorption, counter current flow, minimum liquid-gas ratio, absorption factor, number of plates by graphical construction.

References

1. Unit operations in chemical engineering, Tata Mc Graw-Hill Company limited, New Delhi, Mc Cabe & Smith.
2. Introduction to Chemical Engineering, Tata Mc Graw-Hill Company limited, New Delhi, Badger
3. Mass transfer Operations, Tata Mc Graw-Hill Company limited, New Delhi, Treyball

PO010 605: **Polymer Blends & Composites**

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

Objective

- *To impart basic knowledge on blends and composite materials*

Module 1 (10 hours)
Introduction, preparation of polymer blends, thermodynamic criteria for polymer miscibility, specific interactions, copolymer effect, phase separation, spinodal decomposition, nucleation and growth, phase diagram, morphology, blend characterisation techniques

Module 2 (15 hours)
Structure-property relationship, rubber plastic blends, phase morphology, properties of blends prepared by dynamic vulcanization, technological application, thermoplastic styrene block copolymers, polyester thermoplastic elastomers, thermoplastic polyurethane elastomers, basic structure, manufacture, morphology, commercial grades, applications, thermoplasic 1,2-polybutadiene, trans 1,4-polyisoprene, ionic thermoplastic elastomers, silicone based thermoplastic elastomers, polyamide 1,2-elastomers.

Module 3 (15 hours)
Introduction to particulate and fibre filled composites, applications, function of matrix, function of fibres, polymer-fibre interface, factors influencing the performance of composite, coupling agents, bonding agents, short fibre composites, continuous fibre composites, analysis of long fibre composites, analysis of short fibre composites, critical fibre length, rule of mixtures

Module 4 (10 hours)
Preparation and properties of glass fibre, carbon fibre and aramid fibre, polymer concrete, polymer impregnated concrete, polymeric binders for rocket propellants

Module 5 (10 hours)
Composite manufacturing techniques, hand lay-up, spray-up, compression moulding, vacuum bag moulding, pressure bag moulding, filament winding, resin transfer moulding, pultrusion, Reinforced Reaction Injection Moulding

References

1. Hand book of Elastomers, New Developments and Technology (Eds), A.K. Bhowmic, and H.C. Stephense, Markel Dekker, Inc., New york.
2. O.Olabisi, I.W. Robeson, and M.T. Shaw, Polymer-polymer Miscibility Academic Press, New York, 1979
3. Paul S. Newman (Ed) 'Polymer Blends'" Academic Press, New York, 1978
4. G.Alliger, etal, Rubber world, 164930,51(1971)
5. Goettler inc, the role of the polymeric matrix in the processing and structural prpperties of copmposite materials (J C Sferis and L.Nicolars, (Edn) Plenum, New York 1983.

PO010 606L01: **Bio Medical & Bio Polymers**
(Elective - I)

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

Objective

- *To familiarize various biomedical and biopolymers and their applications*

Module 1 (10 hours)
Biomaterials, biocompatibility, stabilisation, inflammation and wound healing, blood clotting system, kinn system, biological responses to implants, implant design and applications, silicone polymer implants.

Module 2 (15 hours)
Biomedical applications of polymers, permanent implants for function, orthopaedics, cardio vascular, respiratory patches and tubes, digestive system, genitourinary system, nervous system, orbital (corneal and lens prosthesis) permanent implant for cosmoses, other applications of engineered material in clinical practices, silicone implants, polymer membranes, polymer skin, polymeric blood, poly (vinyl pyrollidone)

Module 3 (12 hours)
Contact lenses, hard lenses, gas permeable lenses, flexible lenses, soft lenses, hydrogels, equilibrium swelling, absorption and desorption, oxygen permeability, types of soft lenses, manufacture, cleaning and disinfection.

Module 4 (13 hours)
Dental applications, denture base, denture reliners, crown and bridge resins, plastic teeth, mouth protectors, maxillofacial prosthetic materials, restorative materials, polyelectrolyte based restorative sealants, adhesives, dental impression and duplicating materials, agar, algmater elastomers.

Module 5 (10 hours)
Chemistry of peptides, polypeptides and proteins, synthetic approach to polypeptides and proteins, structural organisation in proteins, nucleic acids, RNA, DNA, structure, chemistry of polysaccharides, starch and cellulose, chemical modifications of cellulose, regenerated cellulose, viscose rayon and cuprammonium rayon

References

1. R.H. Yocum and E.B. Nyquist, Eds., Functional Monomers, Volume 1,Marcel Dekker Inc.,NewYork,1973,Chapter 3,PP 299-487
2. M.A.Galin and M.Ruben, Ed, Soft contact lenses:Clinical and Applied Technology,John Wiley and sons,Inc.,NewYork,1978.
3. Lehninger, "Principles of Biochemistry, Shulz and Bhirmer ,"Principles of protein structure ",Academic Press.
4. H.F. Mark (Ed), Encyclopedia of polymer science and engineering, John Wiley and Sons New York, 1989.
5. Galin and M. Ruben Ed., Soft compact Lenses clinical and applied Technology.
6. John Wiley and Sons, Inc. New York, 1978. Comprehensive Polymer Science Vol.7
7. (Ed) David Byrom, "Bio-Material" Macmillan Publishers Ltd. and ICI Biological products Business, 1991.
8. Wilfred Lynch, Hand book of Silicone rubber fabrication, Van Nostrand Reinhold Company, 450 west 33 rd Street, New York 1000.

PO 010 606 L02: **Information Technology**
(Elective - I)

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

Module 1 (8 hours)
Data Structures, introduction, storage structures for arrays, stacks, application of stacks, queues, pointers and linked allocations, linked linear list, operations, circularly and doubly linked list, applications, sorting techniques, selection sort, bubble sort, exchange sort, searching techniques, sequential searching, binary searching.

Module 2 (12 hours)
Operating systems, generation and history of operating systems, multi programming and time sharing concepts, process states, transition, PCB, interrupt processing, job and process scheduling, disk scheduling, seek optimization, rotational optimization.

Module 3 (15 hours)
Software engineering, planning and cost estimation, importance of software, defining the problem, developing a solution strategy, planning, development process, organizational structure, software cost estimation, introduction, software cost factors, cost estimation techniques, staffing level estimation.

Module 4 (15 hours)

Software design concepts, introduction, fundamental design concepts, modules and modularization criteria, design notations and techniques, detailed design consideration, real time and distributed system design, test plans, milestone, walkthroughs and inspections, design guidelines, computer security, fundamental concepts of cryptosystems.

Module 5 (10 hours)
Computer networks, introduction, uses of computer networks, network hardware & software, reference models, network topologies, examples of network, internet programming, HTML, DHTML, front page, introduction to dream weaver. E-commerce, introduction, applications in business, E-commerce framework.

References

1. Jean-Paul Tremblay& Paul.G.Sorenson, An Introduction to Data Structures with Applications, Mc Graw Hill, II edition, 1984.
2. Harvey.M.Detail, An Introduction to Operating Systems, Addison Wesley Publication Company, 1998.
3. James.L.Peterson, Abraham Silberschatz, Operating System Concepts, Addison Wesley Publication Company, 1985.
4. Richard Fairley, Software Engineering Concepts, Mc Graw Hill, 1985.
5. Pressman R.S., Software Engineering, Mc Graw Hill, II edition, 1987.

PO 010 606 L03: **Engineering Economics & Industrial Management**

(Elective - I)

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Module 1 (12 hours)
Nature and scope of engineering economics, definition and scope of study of the subject, significance of economic analysis in business decisions, demand and supply analysis, determinants of demand, law of demand, Elasticity of demand, Demand forecasting, Law of supply, Elasticity of supply, Market price.

Module 2 (15 hours)
Cost analysis, fixed cost, variable cost, marginal cost, cost output relationship in the short run and the long run, equilibrium of the firm, pricing decisions, situations demand, pricing decisions, pricing in practice, full cost pricing, marginal cost pricing, bid pricing, pricing for a rate of return, statutory price fixation in India, break even analysis, break even point, basic assumptions, break even chart, managerial uses of break even analysis.

Module 3 (12 hours)
Capital budgeting, need for capital budgeting, method of appraising project Profitability, rate of return, pay back period, present value comparison, cost benefit analysis, preparing of feasibility report, appraisal process, economic and commercial feasibility, financial feasibility, technical feasibility.

Module 4 (11 hours)
Work study, production, productivity, factors affecting productivity, role of work study, human factor, methods study, objectives and procedure, SIMO chart, principles of motion economy, work measurement, stop watch time study, rating concept and systems, allowances, work sampling

Module 5 (10 hours)

plant layout, factors governing plant location, objectives of a good plant layout, process layout, product layout and combination layout. Material handling- principles, equipments, methods.

References

1. O.P. Khanna- Industrial Engineeering and Management- Dhanpatrai Publications- New Delhi-1998
2. R. L. Varshney & K.L. Maheswari-Managerial Economics-S Chand and Co.
3. Samuelson P. A. & Nordhaus. W. D-Economics-Mc'Grawhill-1992

PO 010 606 L04: **Total Quality Management & Reliability Engineering**

(Elective - I)

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Module 1 (8 hours)

Basic concepts, evolution of total quality management, definitions of quality, deming, crosby, juran, taguchi, ishikawa theories, inspection, quality control, TQM system, human component, service and product quality, customer orientation.

Module 2 (14 hours)

Quality planning & techniques, quality planning, goal setting, designing for quality, manufacturing for quality, process control, CPK, 6σ, process capability, data based approach, statistical tools, 7QC tools, bench marking, QFD, FMEA, 5S, continuous improvement techniques, POKAYOKE, deming wheel.

Module 3 (12 hours)

Human dimension & system development in TQM, TQM mind set, participation style, team work, team development, quality circle, motivational aspect, change management, documentation, structure, information system, ISO 9000, ISO 14000, QS 9000, certification, clauses, procedure, TQM road map.

Module 4 (14 hours)

Reliability, definition, probabilistic nature of failures, mean failure rate, meantime to failure, meantime between failures, hazard rate, hazard models, weibull model, system reliability, improvement, redundancy, series, parallel and mixed configurations, reliability in design, case studies of aircraft engines, brake system in automobiles and aircraft, electronic equipollents.

Module 5 (12 hours)

Maintainability, introduction, choice of maintenance strategy, mean time to repair (MTTR), factors contributing to mean down time (MDT), fault diagnosis, routine testing for unrevealed faults, factors contributing to mean maintenance time, (MMT), on-condition maintenance, periodic condition monitoring, continuous condition monitoring, economics of maintenance.

References

1. Joel E. Rose, Total Quality Management, 2nd edn., Kogan page Ltd., USA, 1993.
2. Srinath L.S., Reliability Engineering, Affiliated East West Press, New Delhi – 1975.
3. John Bentley, Introduction to Reliability and Quality Engineering, 2nd edn., Addison – Wesley, 1999.
4. John Bank, TQM, Prentice Hall of India Pvt. Ly\td., New Delhi, 1993.

5. Patrick P.T. O' Connor, Practical Reliability Engineering 2edn., John Wiley & Sons, 1985.
6. Balagurusamy E., Reliability Engineering, Tata McGrew Hill Pub. Co., New Delhi, 1984.

PO 010 606L05: **Production Engineering**
(Elective - I)

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

Module 1 (10 hours)
Lathe, types of lathe specification, parts of center lathe, operations, single point tool nomenclature accessories and attachment, capstan and turret lathe, parts, difference, automatic lathe, single spindle and multispindle types.

Module 2 (15 hours)
Shaping, types, operations, parts of standard shaper, specifications, planning, types, parts of double housing, planning machine, operations table drive mechanism only, specifications, milling, types, specifications, operations only, drilling, types, specification, operations, twist drill nomenclature, boring, types, specification, grinding, types, abrasives, girt, grade and structure of grinding wheel, bonding process, fine finishing, honing, super finishing, buffing, metal spraying, electro plating.

Module 3 (10 hours)
Special machining, electrical discharge machining, electro chemical machining, electron beam machining, ultrasonic laser machining, plasma arc machining, abrasive jet machining, chemical machining.

Module 4 (15 hours)
Transfer machines, types, components, N.C. machines, open and closed loop control system, analogy and digital control system, absolute and incremental position control, part programming, manual part programming technique and computer aided part programming technique

Module 5 (10 hours)
Measurement principles, classification of measuring instruments, gauges, height gauge, slip gauges, sine bars, autocollimator, go, no gauges, classification, surface roughness, terms, symbols, measurement.

References

1. S.K. Hajra Choudry, Elements of Workshop Technology Vol. I & II Media promoters and Publishers, 1999, 9th Edition.
2. Workshop Technology, W.A.J. Chapman, Vol. I, II & III.3
3. Manufacturing Technology, M. Hastle Hurst.

PO 010 606 L06: **Project Management**
(Elective - I)

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

Objectives

- *To impart the basic concepts of Project selection.*

- *To develop an understanding of tools, techniques and software available for Project Management.*

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

Module 2 (14 hours)
Cost of the Project, Means of Finance, Financial Evaluation of projects- Pay back period method, Accounting Rate of Return method, Net Present Value method, Internal Rate of Return method, Benefit Cost Ratio method, etc., Simple Problems.

Module 3 (13 hours)
Risk Analysis-risk in economic analysis-measuring risk in investment; Sources, Measures and Perspectives on Risk, Techniques used for risk analysis – Decision trees, Simulation, Break-even Analysis etc., Techniques for Managing Risk.

Module 4 (14 hours)
Project Management- nature and scope- PERT and CPM techniques, Estimates -time, cost, resources (man, material, tool), Crashing of Projects, Project scheduling with constrained resources, resource leveling, resource Allocation.

Module 5 (9 hours)
Computer Aided Project management, Essential Requirement of Project Management Software, MS Project 2010 software, Features and Facilities in Project 2010, Types of Reports available in Project 2010 etc. Project Management Information Systems (PMIS), PMIS sotware, Web- Enabled Project Management.

References

1. Corter, Mastering MS Project 2000, BPB Publishers.
2. Harvey Maylor, Project Management, Pearson Education.
3. Prasanna Chandra, Projects, Tata McGraw Hill.
4. Nagarajan K, *Project Management 4th edition,* New Age International (P) Ltd.
5. Khan & Jain, Financial Management
6. Nicholas J. M. & Steyn H., *Project Management*, Elsevier.
7. Brian Kennemer and Sonia Atchison, *Using Microsoft Project 2010*, Que Publishing.

PO010 607: **Latex Product Lab**

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

Objective

- *To develop practical skill for latex products manufacturing*

1. Preparation of dispersion, slurry and emulsions
2. Creaming of NR latex.
3. Manufacture of rubber bands, balloons, finger caps, household gloves, surgeons' gloves, latex thread and articles by casting.
4. Heat sensitized dipping.
5. Latex impregnation in textiles
6. Preparation of SP, CV and LV rubber
7. Preparation of latex based adhesives

8. Work practice in the production of latex foam
9. Work practice in the production of bonded coir

PO010 608: **Product Manufacturing Lab**

Teaching scheme **Credits:** 2

3 hours practical per week

Objective

- *To create skill for dry rubber and plastic product manufacturing*

1. Determination of Cure time.
2. Effect of mastication time on plasticity/ viscosity
3. Work practice in mastication, band formation, homogenisation and mixing using a laboratory mill
4. Preparation of micro cellular sheet, V-strap, tea mat, teats, injection bottle cap, play ball, man made hose, solvent based adhesives, solid tyre, sponge, eraser and oil seal.
5. Work Practice in calendaring, injection moulding, rotational moulding and extrusion
6. Visit to factories manufacturing tyres and non tyre products.

PO010 701: **Polymer Machinery, Moulds & Dies**

Teaching scheme **Credits:** 3
2 hours lecture and 2 hour tutorial per week

Objective

- *To impart knowledge on various equipments and machinery used in polymer industry*

Module 1 (10 hours)
Rubber and plastics machinery, moulds, dies and testing equipments- general survey and history of development, factors to be considered in their choice. machinery for the production of market grades of rubber and lattices. Working principles, important mechanical and electrical features of the following- latex centrifuge, sheeting rollers and batteries for the production of RSS, machinery used for crumb rubber production

Module 2 (10 hours)
Mixing mills and accessories, Banbury mixer, Brabender plasticorder, size reduction machines, separation machines, fabricating and finishing machinery, moulding presses, calenders and accessories, injection moulding machines, extruders and strainers, web coating and handling equipment,

Module 3 (10 hours)
Pressure vessels, weighing and measuring equipment, pumps, valves, piping, steam generation equipments, lubrication equipments, air handlng equipments, heaters, driers, coolers, miscellaneous equipments used in processing factories, machinery for specific products- tyre and tubes, footwear, hoses and belting, wires and cables, latex and fibre foam

Module 4 (15 hours)
Importance of moulds, basic mould types, equipments, methods and materials used for mould making, elementary principles of design, injection moulds- basic mould construction, single and multicavity moulds, three plate moulds, sprues and gates, cooling system, ejector system, venting degating devices, rubber injection mould, stack moulds, compression and transfer moulds-requirements, construction, mould insert, design, blow moulds- extrusion blow mould, injection blow mould, rotational moulding tools, thermoforming tools, moulds for producing expandable PS, miscellaneous moulds

Module 5 (15 hours)
Importance of extrusion dies, principles of die design, materials used, manufacturing, land length, melt fracture, entry geometry, practical die design, die restriction, streamlining of extrusion dies, screen pack, typical extrusion dies- straight through dies, offset dies, crosshead dies, wire coating, dies for tubular film, flat film dies, sheet dies, tube dies, dies for solid solid sections, dies for multi-colour and multi-material extrusion, mechanically driven dies, calibrators for rigid and semi rigid tubes, calibration of profiles

References

1. Plastic Mould Engineering Handbook- J. Harry, Dubois and Wayne, Van Nostrand
2. Injection Mould Design- R.C.W.Pye
3. Extrusion of Plastics-Heinemann Butterworths
4. Principles of Polymer Processing- E.G.Fischer

PO010 702: **Polymer Testing**

Teaching scheme **Credits:** 3
2 hours lecture and 2 hour tutorial per week

Objective

- *To generate scientific knowledge on testing of polymers*

Module 1 (10 hours)
Standards organizations, BIS, ASTM, BS, DIN, FDA, preparation and conditioning of test pieces, short term testing, stress-strain behaviour in tension, compression and shear, tensile strength, compressive strength, tear strength, flexural strength, Impact- Izod, Charpy

Module 2 (15 hours)
Long term testing, creep, stress relaxation, dynamic mechanical analysis, hardness, abrasion resistance, resilience, heat build- up, ageing

Module 3 (10 hours)
Chemical analysis of polymers, functional group analysis, tacticity analysis, use of mass spectrometry, gas chromatography, IR, C^{13}, H^{1}, ESR, NMR spectroscopy, optical microscopy, SEM, TEM, X-ray diffraction, electron diffraction, neutron diffraction in polymer characterization.

Module 4 (15 hours)
Principle and use of DTA, TGA, DSC and TMA, determination of T_g, T_m, heat of fusion, thermal conductivity, flammability, vicat softening point, heat deflection temperature.

Module 5 (10 hours)
Analysis of dielectric strength, dielectric constant, volume resistivity, surface resistivity, arc resistance, corona resistance, power factor, dissipation factor, loss factor, transparency, refractive index, haze, gloss.

References

1. R.P.Brown, Physical testing of Rubber, Academic Press, New York 1984
2. Vishu Shah, Testing of Plastics
3. ASTM Manual 35,36,37
4. BIS and TST Manual

PO010 703: **Plastic Products- Design & Testing**

Teaching scheme **Credits:** 3

2 hours lecture and 1 hour tutorial per week

Objective

- *To create awareness on design and testing of various plastic products*

Module 1 (7 hours)

Introduction, design principles, steps in product design, functional design, aesthetic design, plastic structure- physical and chemical properties, effect of fillers on properties and performance

Module 2 (10 hours)

Stress and long term property analysis, stress in products- tension, compression and shear, effect of cyclic loading, structural design of products under static and dynamic loads, design of beams and plates, design for stiffness, design for electrical application, design for optical application

Module 3 (10 hours)

Design features of products, inside and outside corners, wall thickness, ribs, tapers, draft angles, weld lines, gate size and location, tolerances, moulded-in-inserts, plastic threads, blind holes, undercuts, hinges, functional surfaces and lettering, snap fitting, welding.

Module 4 (10 hours)

Plastic products- gears, plastic bearings, piping, films, sheets, bottles, water tanks

Module 5 (8 hours)

Product analysis- standard test methods for plastic products- pipe, film, sheet, PU foam, plastic optical goods, food packing containers

References

1. Plastic Products Design Handbook - Edward Miller
2. Plastic Products Design Engg. Handbook - S Levy & J. H. DuBois
3. Product Design With Plastics J.B.Dym
4. Plastics: Product Design and Process Engg. – Harold Belofsky
5. Test Methods- ASTM, BIS
6. Testing of Plastics- Vishu shah

PO010 704: **Chemical Engineering - IV**

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

Objective

- *To familiarize process control instruments and thermodynamics*

Module 1 (7 hours)
Process control-controllers, types, proportional derivative control, proportional integral controller, proportional integral derivative controller, basic principles and transfer functions, open and closed loop systems, first order systems, mercury thermometer

Module 2 (8 hours)
Temperature measurement-different methods like electrical, contact and non-contact methods- thermometers- liquid filled, bimetallic and resistance thermometers, thermocouple, optical pyrometer. Pressure measurement, manometers, U-tube, well type and inclined types, barometer, bourden tube, bellows, diaphragms.

Module 3 (8 hours)
Chemical reaction engineering-classification of chemical reactions, variables affecting the rate of reaction, reaction rate, molecularity and order of a reaction, Arrhenius law, collision theory and transition state theory. integral and differential method of data analysis, ideal batch reactor, semi batch reactor, mixed reactor, plug flow reactor – design equations

Module 4 (7 hours)
Transportation and metering of fluids, pipes and tubings, centrifugal pumps- theory, selection of centrifugal pumps, various types, characteristic curves, priming, cavitation, NPSH, Reciprocating pumps - discharge, slip, power required, indicator diagram

Module 5 (15 hours)
Thermodynamics- fundamental concepts and definitions, zeroth law of thermodynamics, first law applied to non-flow process and steady state flow process, enthalpy, heat capacity, specific heat, entropy and second law of thermodynamics, limitations of first law, statement of second law, Kelvin-Plank statement, Clausius statement, heat reservoirs, heat engines, heat pumps, entropy and unavailable energy, thermodynamic properties of fluids, reference properties, energy properties, derived properties, Gibb's free energy, work function, Maxwell's equations, Clapyeron equation, Clausius-Clapyeron equation, fugacity and activity of pure fluids

References

1. Chemical reaction engineering, Levenspiel, Tata McGraw Hill Company limited, New Delhi
2. Process control, Patranabis, Tata McGraw Hill Company limited, New Delhi
3. Process instrumentation, Patranabis, Tata McGraw Hill Company limited, New Delhi
4. Process system analysis and control, Coughnour & Koppel, Tata McGraw Hill Company limited, New Delhi
5. Chemical engineer's Handbook, Perry, Tata McGraw Hill Company limited, New Delhi
6. Introduction to chemical engineering, Anderson & Wenzel, Tata McGraw Hill Company limited, New Delhi
7. Nag, *Engineering Thermodynamics*,
8. J.M Smith, *Introduction to chemical engineering thermodynamics*, Tata McGraw-Hill, New Delhi

9. Mc Cabe and J.M Smith, *Unit Operations in Chemical Engineering*, McGraw-Hill publishing company, New Delhi
10. B.G.Kyle, Chemical and Process Thermodyanamics, Prentice Hall, 2006
11. K.V.Narayanan, *A Textbook* of Chemical Engineering Thermodynamics,

PO010 705: **Tyre Technology**

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

Objective

- *To impart engineering concepts on tyre manufacturing*

Module 1 (10 hours)
History on the design and development of tyres, current status of tyre industry in India and its future prospects, tyre sizing, different components of a tyre, its geometry, basic functions, functions of a pneumatic tyre, load carrying, vibration and noise reduction, the tyre function as a spring, contribution to road adhesion, tyre friction contribution to driving control, steering control and self aligning torque. Solid tyres, concave tyres, winter tyres, OTR tyre, bicycle tyre, different types of tyres, bias, bias belted, radial, relative merits and demerits, their components, tube and tubeless tyres-basic features.

Module 2 (10 hours)
Cord-rubber composites, failure mechanism of cord reinforced rubber, mechanics of tyre pavement interaction, tyre forces on dry and wet road surface, traction forces on dry, wet, ice, snow and irregular pavements, breaking and traction of tyres, tyre wear, rubber friction, sliding mechanism, various factors affecting friction and sliding, tyre stresses and deformation, tyre noise, mechanism of noise generation, effect of tread pattern, noise level, flatspotting, fatigue resistance, pantographing, pneumatic resilience effect.

Module 3 (10 hours)
Manufacturing techniques of various tyres - two wheeler, car tyres, truck tyres, cycle tyres, cycle tubes, OTR tyres, aircraft tyres, automotive tubes, manufacture of tyre treads, beads, sidewalls, compounding techniques, principles of designing formulations for various rubber components, tyre reinforcement materials (textile, steel, glass, aramid), criteria of selection, different styles and construction, textile treatment (RFL dip)

Module 4 (8 hours)
Tyre mould design, green tyre design principles, methods of building green tyres for bias, bias belted, radial and tubeless tyres, green tyre treatments, tyre curing methods, curing bags, bladders, diaphragms, autoclave, airbag, bagomatic, autoform, post cure inflation, different types of tyre building machines, bead winding machine, bias cutters, curing presses.

Module 5 (7 hours)
Measurement of tyre properties, dimension and size-static and loaded, tyre construction analysis, endurance test, wheel and plunger tests, traction, noise measurements, force and moment characteristics, cornering coefficient aligning torque coefficient, load sensitivity and load transfer sensitivity, rolling resistance, non-uniformity dimensional variations, force variations, radial force variation, lateral force variation concentricity and ply steer, type balance, mileage, evaluations, tyre flaws and separations, X-ray holography, foot print pressure distribution, BIS standards for tyres, tubes and flaps, quality control tests.

References

1. Samuel K. Clark, Mechanics of pneumatic Tires, National Bureau of standards, Monograph, US Govt. printing office, 1971.
2. Tom French, Tyre Technology, Adam Hilger, New York, 1989.
3. F.J. Kovac, Tire Technology, 4th edition, Good year Tire and Rubber Company, Akron, 1978.
4. E. Robecchi, L. Amiki, Mechanics of Tire, 2 Vols, Pirelli, Milano, 197

PO010 706 L01: **Paints & Surface Coatings**

(Elective – II)

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Objective

- *To create knowledge on various types of paints and surface coatings*

Module 1 (10 hours)

Fundamentals of paint science, reflection, refraction, diffraction, colour science, additive colour mixing, gloss, specular gloss, bloom gloss, surface uniformity, hiding power, chromaticity diagrams for colour measurements

Module 2 (15 hours)

Components of paints, paint preparation, formulation, factors affecting pigment dispersion, preparation of pigment dispersion, manufacture, pigments, pigment properties, different types, selection, dispersion and colour matching of pigments, extenders, solvents, different types, solvent properties, oil, driers, resins, dilutents, additives affecting viscosity, interfacial tension, chemical reactions, living micro organisms.

Module 3 (10 hours)

Classification based on polymeric resin, emulsion, oil and alkyd paints, acrylic paints, epoxy coatings, polyurethanes, silicones, formaldehyde based resins, chlorinated rubbers, acrylics, hydrocarbon resins. Classification based on application. Fluoropolymers, vinyl resins, appliance finishes, automotive finishes, coil coatings, can coatings, marine coatings, aircraft finishes.

Module 4 (15 hours)

Mechanism of film formation, physical drying, oxidative drying, chemical drying, factors affecting coating properties, film thickness, film density, internal stresses, pigment volume concentration (PVC), different methods used for film preparation, barrier properties. Mechanical properties and optical properties of coatings, ageing properties, effect of rheological behaviour on paint performance.

Module 5 (10 hours)

Adhesion properties of coatings, factors affecting adhesive bond, thermodynamics of adhesion, destructive methods, nondestructive methods, properties such as floating, silking, cratering, foaming, skinning, flame retardance, slip resistance and storage stability, surface cleaning methods, chemical conversion treatments, paint application, brushing, dip coating, flow coating, roller coating, spray painting, electro deposition, chemiphoretic deposition.

References

1. Swaraj Paul, " Surface coating: Science and Technology" Wiley- Interscience 1985
2. R. Lambourne. " Paint and Surface Coatings-Theory and Practice" Ellis Horwood Chichester 1987

PO 010 706 L02: **Plastics Packaging Technology**

(Elective - II)

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Module 1 (12 hours)

Introduction to plastics packaging, functions of packaging, advantages of plastic packaging, distribution hazards, special requirements of food and medical packaging, packaging legislation and regulation, packaging as a system, elements, approach, package, design, relation criteria for packaging materials, packaging equipment checklist, case histories,

Module 2 (8 hours)

Major packaging plastics, introduction, PE, PP, PS, PVC, polyesters, PVDC, vinylacetate, PVA, EVA, PV Alcohol, PA, PC ionomers & fluoro polymers.

Module 3 (10 hours)

Conversion process, compression & transfer moulding, injection moulding, blow moulding, extrusion, rotary thermoforming, lamination, metallizing, decoration process, shrink wrapping, pallet & stretch wrapping, sealing methods, plasma barrier coatings, energy requirement for conversion.

Module 4 (15 hours)

Extrusion, film and flexible packaging, extrusion, cast film & sheet, blown film, multi layer film & sheet coatings, laminations & co extrusions, stretch and shrink wrap, pouching, sealing, evaluation of seals in flexible packages, advantages of flexible packaging, flexible packaging products, specialized packaging for food products

Module 5 (15 hours)

Thermoformed, moulded and rigid packages, thermoforming packages, position & thermoforming & wrap forming, variations in thermoforming and solid phase pressure forming, scrabbles, twin sheet & melt to mould thermoforming, skin packaging, thermoforming moulds, thermoforming fill real, aseptic thermoforming, advantages & disadvantages of moulding foams, other cushioning materials & distribution packaging, polystyrene & other foams systems cushioning, design of molded cushioning systems, plastic pallets, drums & other shipping containers, testing plastic packages, barrier, migration & compatibility, printing, labeling & pigmenting, sterilization systems and health care products, packaging hazards and their controls, environmental considerations.

References

1. Susan E.M. Seleke, Understanding plastic packaging Technology, Hanser publications – Munich
2. A.S. Altalye, Plastics in packaging, Tata McGraw – Hill publishing Co. Ltd., New Delhi.

PO 010 706 L03: **Process Engineering Economics & Management**

(Elective - II)

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Module 1 (11 hours)
Value of money, equivalence, equation for economic studies and equivalence, amoritation, capital recovery, depreciation, depletion.

Module 2 (12 hours)
Capital requirements for process plants, cost indices, equipment costs, service facilities, capital requirements for completed plan, balance sheet, cost, earnings, profits and returns, variable costs, fixed costs, income statement, economic production charts, capacity factors.

Module 3 (12 hours)
Economics of selecting alternates, annual cost methods, present worth method, equivalent alternate, rate of return and payment time, cash flow analysis, economic balance, economic balance in batch operation, cyclic operations and multiple equipment units.

Module 4 (10 hours)
Micro economics, elasticity of demand and supply, demand forecasting methods, economic analysis, cost analysis, time element, Beep micro economics, Keynesian employment theory, multiplier and accelerator, national income, accounting, business cycle.

Module 5 (15 hours)
Concept of management, principles, managerial functions, scientific management, advanced techniques in management, type of organization, merits and demerits, concept of marking, need, reserach, sales forecasting, product cycle, personnel management, concepts recruitment, selection and training and development, maintenance, merit rating, job evaluation, fatigue, accidents, causes and prevention, labor management of relations, concept of industrial relations.

References

1. Schwyer H.E., "Process Engineering Economics", Mcgraw Hill Book Co., (N.Y)
2. Jelam, F.F., "Cost And Optimisation Engineering ".
3. Peter And Timmerhaus, "Plant Design And Economics For Chemical Engineers.

PO 010 706 L04: **Process Control & Instrumentation**

(Elective - II)

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Module 1 (15 hours)

Principles of measurement and classification of process control instruments, temperature pressure, fluid flow, liquid level, volumetric and mass flow rate, fluid density and specific gravity, viscosity and consistency, pH and concentration, electrical and thermal conductivity, humidity composition by physical and thermal properties and spectroscopy.

Module 2 (15 hours)

Transient response of open loop systems, first order systems, examples, response to step, impulse and sinusoidal forcing functions, first order systems in series, interacting and non interacting types, response of first order systems in series, second order system, transfer functions, examples, response of second order systems to step, impulse and sinusoidal inputs transient response of chemical reactor.

Module 3 (10 hours)

Control system, development of block diagram for feed back control systems, servo and regulator problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transportation lag, feedback characteristics of control systems, block diagram, signal flow graph techniques.

Module 4 (10 hours)

Introduction to frequency response of closed loop systems, concept of stability ROUTH test for stability, stability criterion, bode stability criterion, Niquist diagram, tuning of controller settings.

Module 5 (10 hours)

Process dynamics and applications, dynamics and control of chemical reactors, heat exchangers and distillation columns, digital computer applications, microprocessors and computer control of chemical processes, introduction to PLC programming and DCS.

References

1. Coughanowr D.R. and Koppel L.M., Process Systems Analysis and Control McGraw Hill, New York.
2. P. Harriot, Process Control, Tata McGraw Hill, New Delhi 1977.
3. D.P. Eckman, Industrial Instrumentation, Wiley 1978.

PO 010 706 L05: **Object Oriented Programming**

(Elective - II)

Teaching scheme **Credits: 4**

2 hours lecture and 2 hour tutorial per week

Module 1 (15 hours)
Introduction, basics of C++ programming- loops & decisions, characteristics of object oriented programming language, concepts of classes and objects, encapsulation and abstraction, building classes, declaring objects, member functions, member access controls, arrays as class members, arrays of objects

Module 2 (10 hours)
Inheritance- access control, classification. Constructors and destructors, in-line functions, friend functions and friend classes

Module 3 (15 hours)
Polymorphism-compile time and run time polymorphism, Overloading methods, operator overloading, selecting friend or member functions for operator overloading, virtual methods, definition, usage of virtual methods, abstract classes, simulation using abstract classes,

Module 4 (10 hours)
Dynamic objects, dynamic object allocation, using references with dynamic memory allocations, in-line functions outside class definitions. Case study-C^{++}.

Module 5 (10 hours)
Virtual destructors, virtual base classes, templates-function template, class template

References

1. Data abstraction and OOP in C^{++} -Gordenkeeth Wiley Eastern
2. Object Oriented Programming with C^{++} - E. Balaguruswamy, Tata Mc. Graw Hill
3. C^{++} -Strostroup
4. Object Oriented Programming with C^{++} -Nabajyothy Bjarne
5. Programming Windows 95 -Charles Petzold, Microsoft Press
6. Visual C^{++} Programming - Yashwanth Kaneethkar, BPB
7. Visual Basic from the group UP - Cary Cornessl, Tata Mc. Graw Hill

PO 010 706 L06: **Introduction to Photonics**

(Elective - II)

Teaching scheme **Credits: 4**

2 hours lecture and 2 hour tutorial per week

Objective

- *To create knowledge on the basic concepts of photonics*

Module 1 (10 hours)

Electromagnetic spectrum, nature of light, wave descriptions (spectrum, superposition, interference effects), photon effects (photoelectric effect, momentum, interaction with matter), dual nature of radiation, Grottus-Draper law, Beer-Lambert law, Stark-Einstein law, Sources of light- thermal, discharge lamps, lasers, solid-state sources- LED's and laser diodes

Module 2 (15 hours)

Laser Basics- history, characteristics of laser, coherence, monochromaticiy, collimation, directionality, Principles of laser- stimulated absorption, spontaneous emission, stimulated emission, population inversion. active medium, pumping devices, optical resonator, Laser Action- laser rate equations, 3 and 4 level schemes, laser threshold condition, steady-state laser power. Line width characteristics- homogeneous and inhomogeneous broadening, cavity resonances, spectral and spatial hole burning;

Module 3 (10 hours)

Laser classes and their power range: HeNe, Ar, ion and metal vapour laser, ruby laser, neodymium:YAG, semiconductor laser, excimer lasers, CO_2 lasers, dye lasers, free electron lasers, chemical lasers; Laser cavities- paraxial wave propagation, Gaussian beams, stable and unstable resonators. Laser pulses: Q-switching and mode-locking.

Module 4 (15 hours)

Nonlinear optical processes; second-, third- and higher order processes; perturbation theory and nonlinear coefficients; tunable lasers, crystal optics and the Pockels effect; frequency mixing processes and coupled wave equations; birefringent phase matching, quasi-phase matching and periodically-poled media; optical parametric generation; four-wave mixing and optical phase conjugation; Raman processes; nonlinear fibre optics, pulse compression and optical solitions.

Module 5 (10 hours)

Laser applications, Spectroscopy using etalons, spectrometers, interferometers, Display systems (LCD's, plasmas etc), Range-finding systems and applications-LIDAR. More exotic applications (laser trapping, laser tweezering, different forms of measurements), Trends and new directions in photonic applications. Laser safety, practical tips on experimental techniques, different forms of laser systems used in research

References

1. W. T. Silfvast, *Laser fundamentals*, Cambridge University Press
2. Fuxi Gan, *Laser materials*, World Scientific
3. Smith, F.G. and King, T.A. *Optics and Photonics: An introduction*, Manchester physics
4. Wilson, J. and Hawkes, J.F.B. *Optoelectronics: An introduction* , Prentice Hall
5. Hari Singh Nalwa, Seizō Miyata, *Nonlinear optics of organic molecules and polymers*, CRC Press

6. V. Degiorgio, Christos Flytzanis, Società italiana di fisica, *Nonlinear optical materials: principles and applications* , 1993 IOS Press
7. G. A. Lindsay, K. D. Singer, *Polymers for second-order nonlinear optics*
8. J.P. Fouassier, J. F. Rabek, *Lasers in polymer science technology: applications*,
9. A. N. Chester, S. Martellucci, Anna Maria, *Optical fiber sensors*,
10. R. B. , Wehrspohn and H. S. Kitzerow, *Nanophotonic materials: photonic crystals, plasmonics, and metamaterials*, , Wiley-VCH

PO010 707: **Chemical Engineering Lab**

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

Objective

To generate practical concepts on fluid mechanis and chemical technology methods

Determination of the following parameters

A. Fluid mechanics

1. Fluid flow measurement using orificemeter
2. Fluid flow measurement using venturimeter
3. Verification of Bernoulli's theorem
4. Single tank system
5. Simple distillation
6. Reynolds's experiment
7. Dynamics of thermometer
8. Characteristic curves of a centrifugal pump
9. Characteristic curves of a reciprocating pump

B. Chemical technology

1. Acid value of oils
2. Iodine value of oils
3. Saponification value of oils
4. Sucrose content of sugar
5. Hardness of water
6. Dissolved oxygen in water
7. BOD and COD of water
8. Available chlorine content in bleaching powder
9. Preparation and analysis of soap
10. Flash point and fire point

PO010 708: **Polymer Testing Lab**

Teaching scheme **Credits:** 2

3 hours practical per week

Objective

- *To develop practical skill on testing of polymers*

Mechanical testing of properties of plastics and rubbers

1. Tensile strength
2. Compression strength
3. Flexural strength
4. Tear strength
5. Izod and Charpy impact strength
6. Falling dart impact strength
7. Shore Hardness
8. Abrasion resistance
9. Rebound resilience
10. Flex resistance
11. Compression set

PO 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.

PO 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 7th 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.

PO010 801: **Polymers & Environment**

Teaching scheme **Credits:** 4

3 hours lecture and 2 hour tutorial per week

Objective

- *To create concept on the impact of polymers on environment*

Module 1 (10 hours)

Introduction, resources of polymers, comparison of total energy costs for product manufacture based on polymers, ceramics and metals, polymer production and consumption, comparison of the impact on environment by polymers and other materials, environmental pollution, non-biodegradability of polymers, drawbacks, burning of polymers, remedy for environmental problem by polymers, awareness program.

Module 2 (15 hours)

Need for recycling of plastics from urban solid wastes, waste composition, sorting and segregation of waste, plastics identification, SPI coding, primary recycling, equipments for primary recycling, specific recycling techniques, PE films, PP battery case, crushing and separation, PET films

Module 3 (15 hours)

Secondary recycling, plastics wastes containing paper, hydrolytic treatment, processing of mixed plastics waste, household waste, industrial sector, TPO based materials, use of recyclable plastics in motor vehicles, recoverable material, disposal of residuals, recycling of rubber, difficulty in recycling of rubber products, reclaimator process, WTR, advantages of reclaimed rubber in cost, mixing and processing

Module 4 (10 hours)

Bio-degradation of polymers, introduction, enzymes, enzyme nomenclature, enzyme specificity, physical factors affecting the activity of enzymes, enzyme mechanism, chemical degradation initiates biodegradation, hydrolysis of synthetic biodegradable polymers.

Module 5 (10 hours)

Development of starch based polymers, manufacture of master batch, biodegradation, assessment, soil burial test, biopolyesters, synthesis, isolation, solvent extraction, enzymatic digestion, properties, degradation, intracellular biodegradation, extra cellular biodegradation, thermal degradation, hydrolytic degradation, environmental degradation

References

1. Recycling of plastic materials (Ed) Francesco Paolo La Mantia, Chem Tee Publishing.
2. Degradable polymers, recycling and plastics waste management, (eds) Ann
3. Christine Albertsson and Samuel J. Huang, Marcel Dekker, New York.
4. Plastics Waste Management (ed) Nabil Mustafa, Marcel Dekkar, New York
5. Biodegradable Polymers, Ed. G.J.C. Griffin, Chapman & Hall- Chemistry & Technology

PO010 802: **Rubber Products- Design & Testing**

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

Objective

- *To create awareness on design and testing of various rubber products*

Module 1 (10 hours)
Rubber product design features, compound design principles for NR, SBR, NBR, CR, EPDM, IIR

Module 2 (15 hours)
Rubber as vibration damper, principles of vibration, natural frequency, forced vibrations, undamped vibration, octave rules, frequency of damped vibrations, logarithmic decrements, critical damping, two degrees of freedom, multi degrees of freedom, vibration isolation, dynamic isolation and transmissibility, flexible coupling, engine mounting, dockside fenders

Module 3 (15 hours)
Rubber bearings, bridge bearings, rubber seals, static and dynamic seals, hoses, couplings, sports goods

Module 4 (10 hours)
Belting, conveyer belt, fan and V-belt, cables, rubber- to- metal components, footwear

Module 5 (10 hours)
Rubber compound analysis, chemical analysis of rubber vulcanizate, analytical techniques, spectroscopy, chromatography, thermal analysis, DTA, DSC, TGA, quantitative analysis of rubber compound, physical and chemical tests

References

1. Plastic Products Design Handbook - Edward Miller
2. Theory and Practice of engineering with Rubber, Freakly and Payne Applied Science, London, 1978
3. Rubbery Materials and their Compounds – J A Bridson
4. Rubber Engineering – Indian Rubber Institute
5. Rubber Technology & Manufacture- C M Blow
6. Rubber Products- Manufacturing Technology- A K Bhowmick

PO010 803: **Speciality Polymers**

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Objective

- *To familiarise the special applications of polymers*

Module 1 (15 hours)

High temperature and fire resistant polymers, improving low performance polymers for high temperature use, polymers for low fire hazards, polymers for high temperature resistance, fluoropolymers, aromatic polymers, polyphenylene sulphide, polysulphones, polyesters, polyamides, polyketones, heterocyclic polymers.

Module 2 (10 hours)

Electrical and electronic properties of polymers, insulating properties of polymers, conducting polymers, conducting mechanisms, polyacetylene, polyparaphenylene polypyrrole, organometallic polymers,

Module 3 (15 hours)

Photoconducting polymers, polymers in non-linear optics, polymers with piezoelectric, pyroelectric and ferroelectric properties, photoresists for semi conductor fabrication, negative working photoresists, positive photoresists, electron beam lithography, plasma developable photoresists, optical fibre telecommunication cables.

Module 4 (10 hours)

Ionic polymers, synthesis, physical properties and applications, ion exchange, hydrophilicity, ionomers based on polyethylene, elastomeric ionomers, ionomers based on polystyrene, ionomers based on PTFE, ionomers with polyaromatic backbones, polyelectrolytes for ion exchange, polyelectrolytes based on carboxylates, polymers with integral ions, polyelectrolyte complexes, inorganic ionic polymers.

Module 5 (10 hours)

Liquid crystalline polymers, structure, types, applications, inorganic polymers, polymers containing phosphorous, nitrogen and boron, organometallic polymers, polysiloxanes and metal chelate polymers.

References

1. H.F.Mark, (Ed), Encyclopedia of polymer Science & Engineering, John Wiley & Sons, New York, 1989.
2. Matrin.T.Goosey, Plastics for Electronics, Elsevier, Applied Science, 1985.
3. R.W. Dyson, Specialty Polymers, Chapman & Hall, 2nd edition, 1998.
4. Manas Chanda, Salil.K.Roy, Plastics Technology Hand book, 2nd edition, Marcel
5. Dekker, New York, 1993
6. C.Ku & R.Liepins, Electrical Properties of Polymers, Hanser Publications, Munich 1987.
7. F. Bueche, Physical properties of polymers, Wiley, New York, 1962.
8. J.Mort & G.Pfister, eds. Electronic properties of polymers, Wiley Interscience,

PO010 804 L01: **Adhesive Technology**

(Elective - III)

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Objective

- *To develop knowledge on various concepts of polymer adhesives*

Module 1 (10 hours)

Bond types, immiscible planar substrates, immiscible substrates with interphase formation via chemical reaction, setting, adhesive joint strength, interface, thermodynamics of adhesive, contact angle, work of adhesion, acid base consideration, surface treatment, measure of adhesion, test methods, strength of adhesion, rheology of adhesion

Module 2 (15 hours)

Low energy surface, high energy surface, solvent, solvent cleaning, mechanical abrasion, chemical treatments, primers, plasma treatments, mechanism of adhesion, introduction, mechanical interlocking, mechanically roughened substrates, chemically roughened substrates, role of localized energy dissipation diffusion theory, welding of plastics, polymer/ metal interface, electronic theory, adsorption theory, secondary force interactions, donor-acceptor interactions, primary force interaction.

Module 3 (15 hours)

Hardening by solvent or dispersing medium removal, hardening by cooling, hardening by chemical reaction, non-hardening adhesives, adhesives from natural sources, rubber based adhesives, TPE based adhesives, poly vinyl acetates, poly vinyl alcohols, di isocyanates, cyano acrylate, anaerobic, acrylic, hot melt adhesives, pressure sensitive adhesives

Module 4 (10 hours)

Phenolic resins, tannin formaldehyde resin, lignin based resin, epoxides, structural adhesives in aerospace, adhesives in automobile industry, conductive, adhesives in building construction, adhesives in electrical industry.

Module 5 (10 hours)

Stresses, types of joints, selection of joint detail, joint design criteria, standard test methods, engineering properties of adhesives, non destructive testing, fracture mechanics of adhesive joints, effect of joint geometry, effect of temperature, dynamic and static fatigue, environmental attack, service life prediction

References

1. Skiests (Ed). Handbook of Adhesives, III edition, Van Nostrand Reinhold, 1990
2. Shields, Handbook of Adhesives, Butterworths 1984
3. Pizzi (Ed) Wood Adhesives, Chemistry and Technology, Marcel Dekker 1983.

PO 010 804L02: **Dynamics of Machinery**
(Elective - III)

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

Module 1 (10 hours)
Balancing: - Balancing of rotating masses, static balancing and dynamic balancing, Balancing of several masses rotating in same plane, Balancing of several masses rotating in several planes, Balancing machines. Balancing of reciprocating masses: - The effect of inertia force of the reciprocating mass on the engine. Partial primary balance. Partial balancing of locomotive, Hammer blow, Variation of tractive effort, Swaying couple. Coupled locomotives, Balancing of multi cylinder inline engines, v-engines, Radial engines, Direct and Reverse cranks

Module 2 (15 hours)
Vibrations: - Definitions, simple harmonic motion. Single degree freedom systems: - Undamped free vibrations: - Equations of motion Natural frequency, Energy method, Equilibrium methods, Rayleigh's methods, Equivalent stiffness of spring combinations. Damped free vibrations: - Viscous damping, Free vibrations with viscous damping, over-damped system, critically damped system, under-damped system, Logarithmic decrement, viscous dampers, coulomb damping. Forced Vibrations: - Forced harmonic excitation Rotating unbalance, Reciprocating unbalance. Energy dissipated by damping, vibration isolation and Transmissibility. Vibration measuring instruments.

Module 3 (10 hours)
Two degree freedom systems: - Principal modes of vibration, Rectilinear and angular modes, systems with damping, vibration absorbers, centrifugal pendulum damper, dry friction damper, untuned viscous damper. Multi-degree of freedom system: - Free vibrations, equations of motion, Influence coefficients method, lumped mass and distributed mass systems, Stodola method, Dunkerly's method, Holzer's method, Matrix iteration method. Torsional Vibrations: - Torsionally equivalent shaft, torsional vibration of two-rotor, three-rotor, and geared systems.

Module 4 (15 hours)
Critical speeds of shafts: - Critical speed of a light shaft having a single disc without damping. Critical speeds of a light cantilever shaft with a large heavy disc at its end. Transient vibration: - Laplace transformation, response to an impulsive input, response to a step input, response to a pulse input, phase plane method, shock spectrum. Non-linear vibrations: - Phase plane, undamped free vibration with non-linear spring forces, hard spring, soft spring, Perturbation method, Forced vibration with nonlinear forces, Duffings equation, self excited vibrations.

Module 5 (10 hours)
Noise control: - Sound propagation, decibels, acceptance noise levels, Air columns, Doppler effect, acoustical measurements, microphones and loud speakers, Recording and reproduction of sound, Fourier's theorem and musical scale, Acoustics of buildings, Acoustic impedence filters and human ear.

References

1. Theory of Machines - Thomas Bevan
2. Theory of Machines - P.L. Ballaney
3. Mechanical Vibrations, V edition - G.K. Groover
4. Theory of Vibrations with applications, III Edn - W.T. Thomson

5. Mechanical Vibrations - S. Graham Kelly, Schaum's outlines
6. Fundamentals of Vibrations - Leonard Meirovitch, Mac Graw Hill
7. A text book of sound - L.P. Sharma & H.C. Saxena
8. Engineering Noise Control - D.A. Bies & C.H. Hausen.
9. Noise & Vibration Control - Leo N. Beraneck

PO 010 804 L03: **Computer Aided Design & Manufacture**

(Elective - III)

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Module 1 (10 hours)

Introduction, design process, application of computers for design, creating manufacture database, benefits of CAD, input-output devices in CAD, design work station, graphic terminal, operator input devices, plotters and other output devices, secondary storage.

Module 2 (10 hours)

Functions of graphic package, constructing the geometry, 2D transformations, 3D transformations, conceteration, data base structure and content, wire-frame modeling, surface modeling, solid modeling finite element modeling, digitizing, layering, groups, patterns, local coordinates, automate dimensioning, on line calculation capabilities.

Module 3 (14 hours)

Conventional memorial control (NC), basic components of NC system, NC procedure, NC co ordinate system, NC motion control system, applications of NC, economics of NC, NC part programming, punched tape in NC, tape coding and format, manual part programming, computer assisted part programming, the ATP language, the macro statement in ATP, NC programming with interactive graphics, voice NC programming, manual data input, computer controls in NC, introduction, problems with conventional NC, NC controller technology, computer numerical control, direct numerical control, combined DNC/CNC systems, adaptive control machining systems.

Module 4 (14 hours)

Structural modes of manufacturing process, process control strategies, distributed control versus central control, direct digital control, supervisory computer control, computer aided quality control, technology in Q.C., computer in Q.C., contract inspection methods, non contract inspection methods, optical and non optical, computer aided testing, integration of CAQC with CAD/ CAM manufacturing systems, manufacturing systems, machine tools and related equipment, material handling system, computer integrated manufacturing systems, human labour in the manufacturing system, CIMS benefits.

Module 5 (12 hours)

Group technology (G.T.), introduction, part families, part classification and coding, G.T. machine cells benefits of G.T., computer aided process planning, planning function, retrieval type process planning system, generative process planning system, benefits of CAPP, machinability data systems, computer generated time standards.

References

1. M.P. Groover, E.M. Zimmers, Jr."CAD/CAM"; Computer Aided Design and Manufacturing, Prentice Hall of India, 1987
2. Besent C.B. " Computer aided Design and Manufacturing" Ellis Horwood Ltd England 1980

PO 010 804L04: **Combustion**

(Elective - III)

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Module 1 (12 hours)

Thermodynamics of reactive mixtures: Bond energy-Heat of formation-Heat of reaction-adiabatic flames temperatures-entropy changes for reacting mixtures-chemical equilibrium – equilibrium criteria –evaluation of equilibrium constant and equilibrium composition –simple numerical solutions.

Module 2 (12 hours)

Elements of chemical kinetics: law of mass action-order and molecularity of reaction – rate equation- Arrheniuss law – activation energy – collision theory of reaction rates- Transition state theory-collision theory of reaction rates- Transition state theory –General theory of chain reactions- combustion of carbon monoxide and hydrogen.

Module 3 (12 hours)

Ignition and flammability: methods of ignition –self ignition – thermal theory of ignition – limits of flammability –factors affecting flammability limits- flame quenching- flame propagation- flame velocity- measurement of flame velocity – factors affecting flame speed-premixed and diffusion flames – physical structures and comparison – characteristics of laminar and turbulent flames- theory of laminar flame propagation.

Module 4 (12 hours)

Flame stabilization: Stability diagrams for open flames- mechanisms of flame stabilization – critical boundary-velocity gradient –stabilization by eddies bluff body stabilization – effects of variables on stability limits.

Module 5 (12 hours)

Combustion in solid an liquid propellant: Reactant motors – Classification and types of propellants – desirable properties of grain shapes – burning rates and combustion model of solid propellants- injection of liquid propellants-ignition and ignitors. Miscellaneous topics – droplet combustion – fluidized bed combustion - classification of coal – air pollution.

References

1. Fuels and combustion – Sharma S.P
2. Some fundamentals of combustion – Spalding D.B
3. Fundamentals of combustion – Strehlow . R.A
4. Elementary reaction Kinetics – Lathan J.L
5. Flames – Gaydan and wolfhard.

PO 010 804 L05: **Industrial Hydraulics**

(Elective - III)

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Module 1 (10 hours)

Introduction to hydraulic / pneumatic devices – their application and characteristics – comparison of electric, hydraulic and pneumatic devices.

Module 2 (14 hours)

Pumps and motors: Principle of working – range of displacement and pressures- fixed and variable discharge pumps-gear, screw, vane, piston pumps – axial piston pump-swash pump-bent axis pump. Types of hydraulic motors – their characteristics. Accessories-Hydraulic accumulators – intensifiers-filters-heater-cooler.

Module 3 (12 hours)

Hydraulic valves: Stop valve- non return valve-relief valve-sequence valve-counter balance valve- pressure reducing valve – flow control valve –irection control valves-their principle of operation- and application-JIC symbols of hydraulic- pneumatic components.

Module 4 (10 hours)

Properties of commonly used hydraulic fluids-Typical hydraulic circuits like those used in machine tools –Rivetter- pneumatic Hammer, hydraulic press, and power steering.

Module 5 (14 hours)

Fluidics: Introduction of fluidics devices –Principles of working of common fluidics devices like wall attachment devices – proportional amplifiers-turbulent amplifiers- fluidic logic devices – examples of applications of fluidics devices like edge control of steel plate in rolling mills tension control.

References

1. Daniel Bonteille -Fluid Logic and Industrial automation.
2. John Pippenger & Tyler Hicks - Industrial Hydraulics

PO 010 804L06: **CRYOGENICS**

(Elective - III)

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Module 1 (12 hours)

Introduction: Historical development- present areas involving cryogenic engineering. Basic thermodynamics applied to liquefaction and refrigeration process - isothermal, adiabatic and Joule Thomson expansion process - adiabatic demagnetization – efficiency to liquefaction and coefficient of performances irreversibility and losses.

Module 2 (12 hours)

Low temperature properties of engineering materials: mechanical properties - thermal properties - electrical and magnetic properties. Properties of cryogenic fluids - materials of constructions for cryogenic applications.

Module 3 (12 hours)

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

Module 4 (12 hours)

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

Module 5 (12 hours)

Cryogenic storage and transfer systems - Cryogenic fluid storage vessels cryogenic fluid transfer systems. Application of cryogenics - cryo pumping - superconductivity and super fluidity - cryogenics in space technology - cryogenics in biology and medicine.

References

1. Cryogenic Systems - Barron R. F
2. Cryogenic Engineering - Scot R. W.
3. Cryogenic Engineering - Bell J.H.

PO010 805 G01: **Fibre Technology**

(Elective - IV)

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Objective

- *To develop knowledge on manufacturing, testing and applications of fibres*

Module 1(10 hours)

Introduction, definition of fibre, fibre dimensions, units of measurements, tex, denier, conversion from one system to another, use of fibres in the rubber and plastic industry, polymer products containing fibres, fibre manufacturing industries in India, present status and future prospects

Module 2 (15 hours)

Fibres used in polymer industry- types and sources, chemical composition, properties, concept of order in fibres and polymers, crystallinity and orientation, methods of investigating fibre structure, detailed study of fibre properties such as mechanical properties, electrical properties, moisture absorption, optical properties and fibre friction, relation between fibre properties and structure, uses of vegetable fibres such as cotton, flax, linen, coir, sisal, pineapple, jute, silk, banana, use of animal and mineral fibres.

Module 3 (15 hours)

Man made fibres, physical structure of fibre forming polymers, production, chemical composition, properties and testing of viscose rayon, cellulose acetate, nylon 66 and nylon 6, polyester, acrylic, poly vinyl alcohol, spandex, carbon fibre, metallic fibres, saran, kevlar, nomex, steel wire, finishing and dyeing.

Module 4 (10 hours)

Yarn and textile production from fibres, definition of various textile terms, fibre spinning, drawing of fibres, felting, knitting, lacing, bonding and weaving, properties of yarns, yarn numbering system, brief idea about spinning of cotton yarns and blends

Module 5 (10 hours)

Yarn properties such as count appearance, evenness, strength, abrasion, fatigue, friction, twist, dynamic mechanical properties and their importance, fabrics, brief idea about the construction, cover factor, geometry of weaves, fabric properties such as strength, abrasion resistance, air permeability, bursting strength, thermal properties

References

1. Booths, " Textile Testing", Butterworths, Newness, U.K. 1980
2. Wake and D.B.Wooton, Textile reinforcement of Elastomers," Applied Sciences" 1982
3. Evans," House technology" Applied Science Publishes 1979
4. F.W.Billmeyer, "Text Book of Polymer Science", Wiley – Interscience, 1971
5. Moncrief," Man Made Fibres,
6. Sadov et al, "Chemical technology of fibres and Material" Mir Publishers, Moscow 1978

PO 010 805 G02: **Marketing & Sales Management**

(Elective - IV)

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Module 1 (14 hours)

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

Module 2 (10 hours)

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

Module 3 (12 hours)

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

Module 4 (12 hours)

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

Module 5 (12 hours)

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

References

1. Marketing Management - Philip Khotler
2. Sales Management - Richard, Edward & Norman
3. Industrial Engg & Management - O.P.Khanna
4. Industrial Organisation & Management - Banga & Sarma
5. Organisational Behaviour - Fred Luthans
6. Consumer Behaviour - Schifman & Kanuk
7. Basic marketing - Gundiff
8. Marketing Management for small units - Jain
9. Sales Engg - Lester
10. Salesmanship concept - Thomson

PO 010 805 G03: **Structural Analysis**

(Elective - IV)

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Module 1 (12 hours)

Deflection of determinate beams: Differential equation of the elastic curve- slope and deflection of beams by method of successive integration-Macaulay's method- moment area method-conjugate beam method-deflection due to shear.

Module 2 (14 hours)

Energy Theorems: Strain energy due to axial load-bending-shear and torsion principle of super position-principle of virtual work-Castigliano's first theorem-Betti's theorem-Maxwell's law of reciprocal deflection-unit load method and strain energy method for determination of deflection of statically determinate beams-pin jointed frames-effect of temperature-lack of fit.

Module 3 (12 hours)

Moving loads and influence lines: effect of moving loads-influence lines for reaction, shear force and bending moment for determinate beams-load position-absolute maximum bending moment.

Module 4 (10 hours)

Arches: Theoretical arch-Eddy's theorem-analysis of three hinged arches – moving loads on arches-settlement and temperature effect.

Module 5 (12 hours)

Cables and suspension bridges: General cable theorem-analysis of cables under concentrated and uniformly distributed loads-shape and stresses due to self weight-anchor cables-temperature effect-suspension bridges with three hinged and two hinged stiffening girders-influence lines for bending moment and shear force-temperature stresses in stiffening girder.

References

1. Reddy C.S., Basic Structural Analysis, Tata McGraw Hill Publishing Co.1996.
2. Smith J.C. Structural Analysis, Macmillian Pub.Co.1985.
3. Rajesekharan &Sankarasubramanian,G., Computational Structural Mechanics, Prentice Hall of India, 2001.
4. Wang C.K.& Solomon C.G., Introductory Structural Analysis, McGraw Hill.1968.
5. Sadhu Sindh, Strength of Materials, Khanna Publishers, 1988.
6. Seeli F.B.& Smith J.P., Advanced Mechanics of Materials, John Wiley &Sons, 1993.
7. Norris & Wilbur, Elementary Structural Analysis, McGraw Hill.
8. Junarker S.R., Mechanics of Structures, Vol. II, Charorbar Book Stall.
9. Timoshenko S.P, Young D.H., Theory of structures, McGraw Hill
10. Thadani B.N, Desai J.P, Structural mechanics, Weinall Book Corporation.
11. Punmia B.C., Strength of materials and theory of structures, Vol.II, Laxmi publications.

PO 010 805 G04: **Environmental Impact Analysis**

(Elective - IV)

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Module 1 (10 hours)

Concepts of environmental impact analysis-Environmental protections, legislations, laws and Acts-air quality legislation-energy legislation-fish and wild life resources legislation-historical preservation legislation-factors for consideration in assessing environmental impact concept-short term vs. long term effects.

Module 2 (10 hours)

Socio impact analysis-physical, social, aesthetic and economic environment-examples of types of socio impact analysis.

Module 3 (15 hours)

Air quality impact analysis-air pollutants-sources-atmospheric interactions-environmental impact-assessment methodology, case studies. Noise impact analysis-effects of noise on people-estimating transportation noise impact-examples

Module 4 (15 hours)

Water quality impact analysis-water quality criteria and standards-modelling-water quality impact by projects like High ways, power plants, agriculture and irrigation, forest management, vegetation and wild life impact analysis.

Module 5 (10 hours)

Assessment methodologies-impact on biota-summerisation of environmental impact-checklist method.

Reference

John G Rau, David C Wooten, Environmental impact Analysis Handbook, Mc Graw Hill Book Company, New Delhi, 1980

PO 010 805 G05: **Air Pollution Control**

(Elective - IV)

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Module 1 (10 hours)

Introduction - Significance of air pollution studies, factors that contribute to air pollution - possibilities to air pollution abatemant - air pollution legislation - Techno - administrative aspects of air pollution - Emission and noise standards of Kerala State Pollution Control board.

Module 2 (15 hours)

Gaseous pollutants-source, chemistry, adverse effects on plants, animals and human beings, properties - tolerance levels - carbon monoxide, carbon dioxide, aldehydes, hydrocarbons - compounds of sulphur, compounds of Nitrogen, Oxidants, Hydrogen fluoride - Control of gaseous pollutants - Automobile pollution control.

Module 3 (15 hours)

Particulates in the air - source, nature and adverse effects - control of particulates - settling, filtration, collection in fluids, electrostatic precipitation, conversion to harmless and useful products. Meteorology related to atmosphere - pressure, temperature, lapse rates - humidity - condensation - wind direction and velocity. Effects of meteorological parameters on transport and diffussion. Atmospheric Electricity.

Module 4 (10 hours)

Optics of the atmosphere - Effects of air pollutants on atmospheric visibility - methods of measurement of visibility - Introduction to noise pollution. Photochemical reactions of the atmosphere.

Module 5 (10 hours)

Purpose and principles of measurement of (1) High volume sampler (2) Exhaust gas analyser (petrol and diesel) (3) Stack sampler (4) Sound level meter - industrial hygiene and in plant safety to workers.

References

Henry C Perkins, Air pollution, Mc Graw Hill Pvt Ltd, NewDelhi.

Arthur C Stern, Air pollution, Vol I, II, III, IV, V, Academic Press, NewYork.

Noel De Nevers, Air pollution control Engineering, Mc Graw Hill International Edition, Mc Graw Hill Inc, New Delhi.

M. N. Rao, H V N Rao, Air pollution, Tata Mc Graw Hill Pvt Ltd, NewDelhi.

PO 010 805 G06: **Nanotechnology**

(Elective - IV)

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Module 1 (10 hours)

Introduction: Nanoscale dimension, definition, history, familiarisation with Feynman's speech, principle of nanotechnology, top down and bottom up processes, self-assembled monolayer (SAM), positional assembly, Comparison of the properties of bulk material and nano system. Multidisciplinary approach in nanotechnology, Ethics of nanotechnology

Module 2 (10 hours)

Characterisation: Principle and applications of the following techniques- Scanning probe microscopy (SPM)- atomic force microscopy (AFM) and scanning tunneling microscopy (STM). Electron microscopy- scanning electron microscopy (SEM) and transmission electron microscopy (TEM). Scanning near-field optical microscopy (SNOM), Raman microscopy for characterisation of nanotubes, X-ray Diffraction (XRD)

Module 3 (15 hours)

Nanomaterials: Buckminster fullerene-invention, preparation, structure and applications. Comparison of diamond, graphite and carbon nanotube, Single wall carbon nanotubes (SWCNT) and multi wall carbon nanotubes (MWCNT)- methods of synthesis (arc-growth, laser ablation, CVD routes), structure-property relationship of carbon nanotubes, applications of carbon nanotubes, Nanoclays-preparation, different types, exfoliation and intercalation, quantum wires, quantum dots-preparation, properties and applications

Module 4 (15 hours)

Nano Patterning: Photolithography- positive and negative photoresist, electron beam method, focused ion beam lithography, Dip-pen lithography, Polymer pen lithography, Soft lithography-PDMS as the elastomeric stamp, preparation of elastic stamp, microcontact printing (μCP), replica molding (REM), microtransfer molding (μTM), micromolding in capillaries (MIMIC), and solvent-assisted micromolding (SAMIM), Nano patterns on compact disc, use of compact disc as master

Module 5 (10 hours)

Applications: ***NanoInfoTech***: Information storage- nanocomputer, molecular switch, millipede chip, super chip, nanocrystal, nanotelevision and conventional television

Nanobiotechlogy: Interaction between bimolecules and nanoparticle surface, nanoprobes in medical diagnostics and biotechnology, Nano medicines, DNA printing, Nano-bio-info convergence

Other applications- Micro Electro Mechanical Systems (MEMS), development, applications, Nanosensor, nanotiles, nanocatalyst, smart dust, nano crystalline silver for bacterial inhibition, nanometric powders for propellants and sintered ceramics. Nanoparticles for sun barrier products. In Photostat, printing, solar cell, battery

References

1. Engines of Creation- K. Eric Drexler
2. Nanosystems: molecular machinery, manufacturing, and computation- K. Eric Drexler, Wiley Interscience, 1992
3. Nanotechnology - A Gentle Introduction to the Next Big Idea- Ratner and Ratner, Prentice Hall PTR, (2002)
4. An introduction to the world of nano design- Michael Rieth/ World Scientific Publishing Co., 2003

5. Nanophysics and Nanotechnology: An Introduction to Modern Concepts- Edward L. Wolf, Wiley-VCH, 2004.
6. Nano Essentials- T.Pradeep/TMH
7. Characterization of Nanophase materials – Z.L Wang /Wiley-VCH,2000.
8. Nano- and Micro-Electromechanical Systems: Fundamentals of Nano- and Microengineering- Sergey Edward Lyshevski, 2005
9. Nano Materials- A.K.Bandyopadhyay/ New Age Publishers
10. Nano Engineering in Science & Technology : An introduction to the world of nano design- Michael Rieth/ World Scientific Publishing Co., Inc 2003

PO010 806: **Polymer Blends & Composites Lab**

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

Objective

- *To generate skills on production of polymer blends and composites*

1. Preparation and characterisation of thermoplastic elastomers from rubber-plastic blends.
    a. Miscible binary system (solution and melt mixing)
    b. Immiscible binary system (solution and melt mixing)
    c. Compatibilised binary system (solution and melt mixing)
2. Preparation of miscible polymer blends, phase separation, LCST measurements.
3. Blending of NR with SBR, BR and EPDM.
4. Hand Lay up technique and Compression Moulding.

PO010 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.

PO010 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.