THIRD SEMESTER

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 Δ, ∇, E, μ and $\delta\,\delta$ - 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

- Erwin Kreyszing – Advance Engg. Mathematics – Wiley Eastern Ltd.
- B.S. Grewal – Higher Engg. Mathematics - Khanna Publishers
- B.V. Ramana - Higher Engg. Mathematics – McGraw Hill
- K Venkataraman- Numerical methods in science and Engg -National publishing co
- S.S Sastry - Introductory methods of Numerical Analysis -PHI
- T.Veerarajan and T.Ramachandran- Numerical Methods- McGraw Hill
- Babu Ram – Engg. Mathematics -Pearson.

- 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

- The functional aspects of communication skills, P.Prasad and Rajendra K. Sharma, S.K. Kataria and sons, 2007
- Communication skills for Engineers and Scientists, Sangeeta Sharma and Binod Mishra, PHI Learning private limited, 2010
- Professional Communication, Kumkum Bhardwaj, I.K. International (P) House limited, 2008
- 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

- F.W. Billmeyer, Textbook of Polymer Science, Wiley international publishers, 1984.
- Joel R. Fried, Polymer science and Technology, Prentice Hall, NJ, 1995
- J.M.G. Cowie, Polymers: Chemistry and Physics of Modern Materials, Blackie, London, 1991.
- R.J. Young and P.Lovell, Introduction to Polymers, 2nd Ed., Chapman & Hall, 1991.
- Premamoy Ghosh, Polymer Science and Technology of Plastics and Rubbers, Tata McGraw - Hill, New Delhi, 1990.
- H.R. Allcock and F.W. Lampe, "Contemporary Polymer Chemistry", Prentice Hall 1981.

- F.W.Billmeyer, " Text Book of Polymer Science", Wiley Interscience, 1971.
- 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

- Programming in C : E Balaguruswamy
- Let us C : Y.P.Kannetkar
- Pointers in C : Y.P.Kannetkar
- 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

- Morrison & Boyd, Organic Chemistry, Prentice Hall. New Delhi, 6th edition,1992
- B.S.Bahl and Arun Bhal, Advanced Organic Chemistry, S. Chand & Co. Ltd., New Delhi, 15th edition, 1998
- I.L.Finar, Textbook of Organic Chemistry, ELBS, 5th edition, 1996
- 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

- **Timoshenko.S.P, Strength of Materials, Part 1,D.Van Nostrand company, Inc.Newyork.**
- **Bansal R.K., Strength of Materials, Lakshmi Publications, New Delhi.**
- **Mott, Robert L, Applied strength of materials, 5th Edn, Prentice Hall of India.**

- **Popov E.P., Engineering Mechanics of solids, Prentice Hall of India, New Delhi..**

Reference Books

- **Nash.W.A , Strength of Materials, Schaum's Outlines,$th Edn, TMH**
- **Gere, James M , Mechanics of Materials, Cengage Learning.**
- **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*

- **Organic synthesis**
  - Synthesis of ethyl n- butyl acetoacetate by the acetoacetic ester condensation
  - Synthesis of 3-nitrobenzoic acid from benzoic acid
  - Nitration of aromatic hydrocarbons.
  - Side chain oxidation of aromatic hydrocarbons.
  - Benzoylation of phenols.
  - Preparation of solid esters.
  - Bromination of amines.

- **Purification and characterization of organic compounds**
  - 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.
  - Identify the components of the given binary mixture.
  - Checking the purity of the separated components on TLC plates.

PO010 308: **Computer Lab**

Teaching scheme **Credits: 2 3**

hours practical per week

- Familiarisation of DOS commands and WINDOWS.
- Simple C programs with control statements and loops.
- Programs handling one-dimensional array.
- Programs handling multidimensional array
- Programs using a simple function.
- Functions having arguments.
- Recursive functions.
- Programs handling structures.
- Programs using pointers.
- Programs involving files.
- A simple graphic program.

FOURTH SEMESTER

EN010 401: Engineering Mathematics III

Teaching scheme **Credits: 4**

2 hours lecture and 2 hour tutorial per week

(Common to all branches)

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

MODULE 1 Fourier series (12 hours)

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

MODULE 2 Fourier Transform (12 hours)

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

MODULE 3 Partial differential equations (12 hours)

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

MODULE 4 Probability distribution (12 hours)

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

MODULE 5 Testing of hypothesis (12 hours)

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

References

- Bali& Iyengar – A text books of Engg. Mathematics – Laxmi Publications Ltd.
- M.K. Venkataraman – Engg. Mathematics vol II 3rd year part A & B – National Publishing Co.
- I.N. Sneddon – Elements of partial differential equations – Mc Graw Hill
- B.V. Ramana – Higher Engg. Mathematics – Mc Graw Hill

- Richard A Johnson – Miller Fread's probability & Statistics for Engineers- Pearson/ PHI
- T. Veerarajan – Engg. Mathematics – Mc Graw Hill
- G. Haribaskaran – Probability, Queueing theory and reliability Engg. – Laxmi Publications
- V. Sundarapandian - probability ,Statistics and Queueing theory – PHI
- H.C.Taneja – Advanced Engg. Mathematics Vol II – I.K.International
- 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

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

Reference Books

- Martand Telsang, *Industrial Engineering and Production Management.*
- Khanna O.P., *Industrial Engineering and Management*, Dhanpat Rai and Co.
- Philip Kotler, *Marketing Management*, Prentice Hall of India.
- Sharma S. C. & Banga T. R., *Industrial Organisation and Engineering Economics,* Khanna Publishers.
- 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 , 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

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

- Paul C. Painter and Michael M. Coleman, Fundamentals of Polymer Science, Technomic Publishing Co. Inc., Lancaster, USA, 1994.
- Ulf W. Gedde, Polymer Physics, Chapman & Hall, 1995.
- D.W. Van Krevelen And P.J. Hoftyzen, "Properties Of Polymer, 3rd Edition Elsevier Scientific Publishing Company Amsterdam – Oxford – Newyork. 1990
- J.E. Mark Ed.AIP, Physical Properties Of Polymers Hand Book, Williston, Vt, 1996.
- D.A.Seanor, ed., Electrical properties of polymers, Acadamic press, Newyork, 1982.
- Jozef.Bicerano, Prediction Of Polymer Properties, Second Edition, Marcel Dekker Inc. Newyork, 1995.
- 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

- Mc Cabe and J.M Smith, *Unit Operations in Chemical Engineering*, McGraw-Hill publishing company, New Delhi
- Streeter, *Fluid Mechanics*,
- Jagadish Lal, *Fluid Mechanics*,
- P.N Modi, *Hydraulics and Fluid mechanics*,
- 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

- Electrical Technology -B.L.Thereja
- Electrical Machines -R.K. Rajput
- Electrical Design Estimating And Costing -K.B. Raina & Bhattacharya
- Electrical machines and Power systems -Vincent Del Toro
- 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*

- 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.
- Quantitative estimation of the following monomers: Aniline, Phenol, Acetone, Ethyl Acetate, Formaldehyde, Acrylonitrile, Urea, Glycol, Methyl methacrylate
- Determination of molecular weight by viscosity method.
- Estimation of Polymers: Acrylonitrile content of NBR, Chlorine content of CR, Rubber hydrocarbon content of NR.
- 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

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

GROUP B

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

FIFTH SEMESTER

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 , $\frac{11}{zz}$ - 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

- B.V. Ramana – Higher Engg. Mathematics – Mc Graw Hill
- M.R.Spicgel , S.Lipschutz , John J. Schiller, D.Spellman – Complex variables, schanm's outline series - Mc Graw Hill

- S.Bathul – text book of Engg.Mathematics – Special functions and complex variables – PHI
- B.S. Grewal – Numerical methods in Engg. and science - Khanna Publishers
- Dr.M.K Venkataraman- Numerical methods in science and Engg -National publishing co
- S.S Sastry - Introductory methods of Numerical Analysis -PHI
- P.K.Gupta and D.S. Hira – Operations Research – S.Chand
- Panneer Selvam– Operations Research – PHI
- 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

- K.J. Saunders, "Organic Polymer Chemistry, Chapman and Hall ", London.1973.
- J.A. Brydson, " Plastic materials", Newnes Butterworths.
- 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

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

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

- D. C. Blackley, High Polymer Latices, Vol I&II, Maclaren & Sons, London
- Madge, Latex Foam Rubber, Maclaren & Sons Ltd; 1982
- Mausser, Vanderblit Latex Handbook, 3rd edition, Pub.R.T.Vanderbilt Co. Inc., U.S.A. 1987
- 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

- J.A. Brydson, Rubber Chemistry, allied Science publishers, London, 1978.
- M.Morton, Rubber Technology, Van Nostrand Reinhold, 1987.
- J.A. Brydson, Rubber Materials and Their Compounds Elsevier, 1988.
- 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*

- Specification tests for field latex
  Viscosity, density, pH
- 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.
- 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*

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

SIXTH SEMESTER

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 and R charts, calculation of 3-sigma limits for , control charts for range, OC curve for chart, OC curve for R chart, average run length (ARL) for the 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

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

- Edited by Michael L. Berlin Plastics Engineering. Handbook. Society of the plastic Industries Chapman & Hall NY 1991.
- James L. Throne, Technology of Thermoforming. Hanser, Publisher Munmich 1996.
- M.J. Stevens and J.A. Covas, Extruder principle and operation. Chapman & Hall UK, 2nd edtion 1995.
- 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

- Production System - J.L.Riggs
- Production Control - Hiegel
- Human Factors in Engg. Design - Mc Cornic, E.J.
- Time and Motion Study - Barnes R.M.
- Operations Management - Buffa E.S.
- Value Engineering - Miles L.D.
- Methods Engineering -Krick
- 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

- Unit operations in chemical engineering, Tata Mc Graw-Hill Company limited, New Delhi, Mc Cabe & Smith.
- Introduction to Chemical Engineering, Tata Mc Graw-Hill Company limited, New Delhi, Badger
- 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

- Hand book of Elastomers, New Developments and Technology (Eds), A.K. Bhowmic, and H.C. Stephense, Markel Dekker, Inc., New york.
- O.Olabisi, I.W. Robeson, and M.T. Shaw, Polymer-polymer Miscibility Academic Press, New York, 1979
- Paul S. Newman (Ed) 'Polymer Blends'" Academic Press, New York, 1978
- G.Alliger, etal, Rubber world, 164930,51(1971)
- 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

- R.H. Yocum and E.B. Nyquist, Eds., Functional Monomers, Volume 1,Marcel Dekker Inc.,NewYork,1973,Chapter 3,PP 299-487
- M.A.Galin and M.Ruben, Ed, Soft contact lenses:Clinical and Applied Technology,John Wiley and sons,Inc.,NewYork,1978.
- Lehninger, "Principles of Biochemistry, Shulz and Bhirmer ,"Principles of protein structure ",Academic Press.
- H.F. Mark (Ed), Encyclopedia of polymer science and engineering, John Wiley and Sons New York, 1989.
- Galin and M. Ruben Ed., Soft compact Lenses clinical and applied Technology.
- John Wiley and Sons, Inc. New York, 1978. Comprehensive Polymer Science Vol.7
- (Ed) David Byrom, "Bio-Material" Macmillan Publishers Ltd. and ICI Biological products Business, 1991.

- 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

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

- 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

- O.P. Khanna- Industrial Engineeering and Management- Dhanpatrai Publications- New Delhi-1998
- R. L. Varshney & K.L. Maheswari-Managerial Economics-S Chand and Co.
- 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, 6, 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

- Joel E. Rose, Total Quality Management, 2nd edn., Kogan page Ltd., USA, 1993.
- Srinath L.S., Reliability Engineering, Affiliated East West Press, New Delhi – 1975.
- John Bentley, Introduction to Reliability and Quality Engineering, 2nd edn., Addison – Wesley, 1999.
- John Bank, TQM, Prentice Hall of India Pvt. Ly\td., New Delhi, 1993.
- Patrick P.T. O' Connor, Practical Reliability Engineering 2edn., John Wiley & Sons, 1985.
- 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

- S.K. Hajra Choudry, Elements of Workshop Technology Vol. I & II Media promoters and Publishers, 1999, 9th Edition.
- Workshop Technology, W.A.J. Chapman, Vol. I, II & III.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

- Corter, Mastering MS Project 2000, BPB Publishers.
- Harvey Maylor, Project Management, Pearson Education.
- Prasanna Chandra, Projects, Tata McGraw Hill.
- Nagarajan K, *Project Management 4th edition,* New Age International (P) Ltd.
- Khan & Jain, Financial Management
- Nicholas J. M. & Steyn H., *Project Management*, Elsevier.
- 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*

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

- Work practice in the production of latex foam
- 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*

- Determination of Cure time.
- Effect of mastication time on plasticity/ viscosity
- Work practice in mastication, band formation, homogenisation and mixing using a laboratory mill
- 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.
- Work Practice in calendaring, injection moulding, rotational moulding and extrusion
- Visit to factories manufacturing tyres and non tyre products.