BE (Polymer Engineering)

BE (POLY) - I SEMESTER

THEORY			SESSIONAL		
CODE	**TITLE**	**UNIT**	**CODE**	**TITLE**	**UNIT**
HU 1101	Technical English	1.0	ME 1102	Engineering Graphics	1.0
PH 1101	Physics- I	1.0	CP 1202	Unix & C Programming	1.0
CH 1201	Engineering Chemistry	1.0	PH 1102/	Physics Lab./	
MA 1101	Mathematics- I	1.0	CH 1202	Chemistry Lab.	0.5
ME 1101	Engineering Mechanics	1.0	PE 1102	Work Shop Practice- I	0.5
			GA 1002	NCC/ NSS/ PT & Games/ Creative Arts	0.5

BE (POLY) - II SEMESTER

MA 2101	Mathematics- II	1.0	ME 2102	Computer Aided Drafting	1.0
EE 2101	Basic Electrical Engineering	1.0	CH 1202/	Chemistry Lab./	
CP 2101	Data Structure in C++	1.0	PH 1102	Physics Lab.	0.5
CH 2103	Environmental Science	1.0	ME 2104/	Engineering Mechanics Lab./	
PH 2103	Physics- II	1.0	EE 3102	Basic Electrical Engineering Lab.	0.5
			CP 2102	Data Structure Lab.	0.5
			PE 2102	Workshop Practice- II	0.5
			GA 2002	NCC/ NSS/ PT & Games/ Creative Arts	0.5

BE (POLY) - III SEMESTER

EC 3101	Basic Electronics	1.0	EC 3102	Basic Electronics Lab	0.5
MA 3101	Mathematics III	1.0	EE 3102	Basic Electrical Engg Lab.	0.5
EE 3101	Introduction to System Theory	1.0	PL 3102	Basic Polymer Engg Lab (Poly)	0.5
ME 3206	Thermal Engineering	1.0	PH 3102	Material Science Lab (Poly/EE/EC)	0.5
PL 3101	Introduction to Polymer Engineering	1.0			
PH 3101	Material Science- (Poly/EEE/ECE)	1.0			

BE (POLY) - IV SEMESTER

PL4101	Basic Polymer Chemistry	1.0	PL4102	Polymer Chemistry Lab –I	0.5
PL4201	Fluid Mechanics	1.0	PL4106	Chemical Engineering Lab – 1	0.5
PL4103	Macrmolecular Science- I	1.0	MA5002	Programming Lab	0.5
PL4105	Chemical Engineering- I	1.0	PL4104	Macromolecular Science Lab – 1	0.5
PL4107	Heat Transfer	1.0			
MA5001	Computational Methods	1.0			

BE (POLY) - V SEMESTER

PL 5105	Chemical Engineering- II	1.0	PL 5106	Chemical Engineering Lab– II	0.5
PL 5101	Polymer Processing- I	1.0	PL 5102	Polymer Processing Lab- I	0.5
PL 5103	Macromolecular Science- II	1.0	PL 5104	Macromolecular Science Lab- II	0.5
PL 5107	Strength of Materials	1.0	PL 5108	Strength of Materials Lab	0.5
MA 5003	FEM and Stat	1.0			
PL 5109	Polymer Technology I	1.0			

BE (POLY) - VI SEMESTER

PL 6101	Polymer Processing- II	1.0	PL 6102	Polymer Processing Lab- II	0.5
PL 6103	Die Mould Design & Fabrication	1.0	PL 6104	Die Mould Design Lab	0.5
PL 6105	Elastomer Technology	1.0	PL 6106	Elastomer Technology Lab	0.5
PL 6107	Polymer Rheology	1.0	PL 6112	Compounding and Testing Lab	0.5
PL 6111	Polymer Characterization & Testing	1.0			
PL 6109	Polymer Technology- II	1.0			

BE (POLY) - VII SEMESTER

PL 7101	Computer Aided Polymer Processing	1.0	PL 7102	Computer Aided Engineering Lab	0.5
PL 7105	Polymer Reaction Engineering	1.0	PL 7110	Project- I	0.5
PL 7103	Macromolecular Science- III	1.0	PL 7106	Polymer Synthesis & Dev. Lab	0.5
PL 7105	Design of Plastics Machinery Components	1.0	PL 7108	Design Lab	0.5
PL 7109	Surface Coating and Adhesiion Technology	1.0			
PE 7209	Engineering Economy	1.0			

BE (POLY) - VIII SEMESTER

PL 8101	Polymer Blends & Composites	1.0	PL 8102	Polymer Blends & Composites Lab	0.5
PL 8103	Industrial Chemical Processing	1.0	PL 8110	Project- II	0.5
PL 8105	Process Control and Instrumentation	1.0	PL 8106	Process Control Lab	0.5
PL 8107	Industrial Management	1.0	PL 8104	Die and Mould Fabrication WShop	0.5
PL 8109	Fiber Science & Technology	1.0			
	Ellective	1.0			

List of Elective

PL 8111	Biomedical Applications of Polymers
PL 8113	Recycling and Recovery of Polymers
PL 8115	Leather and Footwear Technology
PL 8117	Packaging Technology
PL 8119	Design of Plastics Products
PL 8121	Basics in Nano-Technology
PL 8123	Natural Polymers
PL 8125	Soft Computing

FIRST SEMESTER

HU 1101	TECHNICAL ENGLISH	1.0

MODULE – I

Single word substitution, Idioms and phrases, Pairs of words, Common errors, Précis, Comprehension, Expansion.

MODULE – II

Official Correspondence - Memorandum, Notice, Agenda, Minutes, Circular letter, applying for a job, Resume, Demo-official letter.

MODULE – III

Business Correspondence-Types, sales letters; Social Correspondence- Invitation to speak, Congratulations; etc.

MODULE – IV

Report writing; general and technical report, Definition, Types, structure.

MODULE – V

Technical proposals, Definitions, types and format.

MODULE – VI

Research papers and articles.

MODULE – VII

Mechanics of manuscript preparation.

BOOKS FOR REFERENCE:

1. Blickle, Margaret D., and K.W.Houp.
2. Reports for Science and Industry, Henry Holt & Co. N.Y.
3. Duddy, E.A. & M.J. Freeman Written Communication in Business, Amercian book Co. N.Y.
4. Berry, Thomas Elliot, The most Common Mistakes in English Usage; Tata McGraw Hill.
5. Stevensin, B.W., J.R. Spicer and E.C. Ames, English in Business and Engineering. Prentice Hall, Eaglewood
6. Cliffs, N.J.
7. Raul, Asha, Effective Business Communication, Prentice Hall of India.
8. Singh B. Business Correspondence including Bank letters.
9. Singh B. Theory and Practice of Business Correspondence, HPJ Kapoor Publications.
10. Report Writing and Business Correspondence Mohan and Sharma, Tata McGraw Hill Publications, India.
11. Best, W.D. The Students companion, Rupa & Co. Publications.

PH 1101	PHYSICS- I	1.0

MODULE – I

Waves and Oscillations: (SS* : Wave motion: longitudinal and transverse waves, plane waves, phase velocity). Wave packets and group velocity, wave equation, superposition of waves (RHK-Ch-18), equation of motion of simple harmonic oscillator and solutions, damped harmonic motion and forced oscillations(RHK 17.2-17.4,17.7,17.8)

[6]

MODULE – II

Fields: Vector and scalar fields, physical and mathematical concepts of gradient, divergence and curl (Cartesian coordinates only), Gauss's theorem and Stokes' theorem (Statements only, SAD-Ch.3).

[5]

MODULE – III

Electromagnetic Theory: Gauss's law in integral and differential form, electric potential and relation with E(SAD 4.5-4.8),(SS*- capacitance(SAD-6.5) and electrostatic energy density (SAD 4.10)), dielectrics, three electric vectors, dielectric susceptibility boundary conditions on E and D(SAD 5.5-5.7, 5.9).

[5]

Amperes law in integral and differential form, applications.(SAD 7.1-7.4), Hall effect (RHK-32.4), three magnetic vectors (SAD 7.5), magnetic permeability and susceptibility, boundary conditions on B and H (SAD 8.5-8.7).

[5]

Faraday's law in integral and differential form(SAD 9.2-9.3), (SS - Inductance, magnetic energy density (SAD 8.8, 8.9)), continuity equation for charge (SAD 5.8), displacement current (SAD 9.4), Maxwell's equations in free space (SAD 9.5), electromagnetic wave equation for plane waves in dielectric medium and free space, relation between $\vec{E}$, $\vec{B}$ and $\vec{k}$, Poyinting vector (SAD 10.3-10.7).

[5]

MODULE – IV

Plasma Physics: Plasma state, types of plasma, applications of plasma(FFC-Ch-1,2)

[4]

MODULE – V

Physical Optics:

Interference: Two-Beam Interference(AG 12.1-12.6), interference in thin films and wedge-shaped layers(AG 13.8-13.9), reflection and anti-reflection coatings(AG 13.2-13.4), applications of interferometry: Newton's rings(AG 13.10), Michelson' Interferometer (AG 13.11)

[5]

Diffraction: Fraunhofer diffraction by single slit(AG 16.1-16.3) , double slit and grating (AG 16.6-16.8), limit of resolution, Rayleigh criterion(AG 16.5), Fresnel diffraction(Qualitative, AG 17.1-17.3)

[5]

Polarization : (SS- Polarization of light, Malus's law, polarization by reflection, Brewster's law, Double refraction) Analysis of linearly and circularly polarized light(RHK 44.1-44.5), Fresnel's equations and their applications (AG 21.1-21.2)

[5]

Text Books:

1. Mathew N.O. Sadiku (SAD), Elements of Electromagnetics, Oxford University Press
2. (2001)
3. A.Ghatak(AG), Optics, 3rd Edition, Tata Mcgraw Hill, 2005
4. Resnick, Halliday and Krane(RHK), Physics- Part-I & II, 5th Edition, John Wiley (
5. 2002)
6. F.F.Chen(FFC), Introduction to Plasma Physics, 2nd Edition, Plenum Press, 1994

References:

1. W.H.Hayt and J.A.Buck, Engineering Electromagnetics, Tata McGraw Hill (2006)
2. M.R.Srinivasan, Physics for Engineers, New Age International, 1996
3. S.N.Sen, Introduction to Plasma Physics, Pragati Prakasan, Meerut -1, India

MODULE – I

Chemical Bonding: Trends in periodic properties (ionization energy, electron affinity, electro negativity), VBT, VSEPR theory, MOT for diatomic molecules and polyatomic molecules, coordination complexes & ligands, CFT, colour and magnetism of coordination complexes, spectrochemical series

MODULE –II

Kinetics and catalysis: kinetics of chain reactions, parallel reactions, side reactions, fast reactions in solutions, flash photolysis, kinetics of catalytic action (acid base catalysis, biological catalysis), application of catalyst in industrially important processes (Haber's processes, Ostwald process, Bergius process)

MODULE – III

Thermo-chemistry and Fuels: Hess's law, entropy, enthalpy and combustion calculations, characterization and application of fossil fuels, solid fuel (carbonization & gassification), liquid fuels (refining, reforming, petrol & diesel, knocking characteristics, octane and cetane number) and gaseous fuels (water gas, producer gas, coal gas and biogas), lubricants and its properties

MODULE –IV

Electrochemistry and corrosion sciences: Redox process cell, potential and free energy, galvanic cells, electrolysis and Nernst's equation, Fuel cells, and its applications, chemical and electrochemical corrosion, general methods of corrosion prevention (with brief introduction to chemistry of paints, varnishes and enamel)

MODULE –V

Fundamentals of spectroscopic techniques: Basic principles of vibrational, rotational and Mossbauer spectroscopy

MODULE – VI & VII

Macromolecules: Classification, Addition and Condensation polymers, molecular weight of polymers (M_n, M_w, M_v), glass transition temperature (T_g), structure property relationship in polymers (chemical, electrical, optical and mechanical), examples and use of inorganic polymers, synthesis of some commercially important polymers and their use (Nylon 6, Nylon 6, 6, PE, PET, PS)

MODULE – VI & VII

An introduction to computational chemistry

Text Book:

1. Applied chemistry A text book for engineers and technologists, H. D. Gesser, Plenum publishers.
2. Inorganic chemistry: J. D. Lee.
3. Engineering chemistry: Sashi Chawla

Reference:

1. Fundamentals of molecular spectroscopy: C. N. Banwell, TMH publication
2. Computational chemistry: E. Lewars, Kluwer publication
3. Physical chemistry: P. W. Atkins

Analytical Trigonometry:

De-Moivre's Theorem and its applications. Expansion of Sinx and Cosx in powers of x. Complex arguments. Separation into real and imaginary parts Gregory's Result. Expansions. Summation of trigonometric Series. Hyperbolic functions.

(8L)

Differential Calculus:

Successive Differentiation. Leibnitz's Theorem. Rolle's Theorem. Lagrange's and Cauchy's Mean value Theorem. Generatalised Mean value Theorem. Taylor's and Maclaurin's infinite series. Cartesion and polar subtangenent and Subnormal. Pedal equations. Orthogonal intersection of curves. Curvature and radius of Curvature in case of Cartesian parametric, polar, pedal and trangential polar forms. Centre of curvature and evolute. Indeterminate forms L Hospital's Rule. Concavity, convexity and points of inflexion. Asymptotes (cartesian Co-ordinates only).

Functions of two variables. Partial derivatives. Euler's Theorem on Homogeneous functions. Its generalisation and extension. Total differential and derivatives. Errors and Approximations. Taylor's series in case of two variables. Maxima and Minima of two variables. Lagrange's method of Undertermined multipliers in case of two and three variables. Jacobians. Envelope of curves. Tangent planes and Normal lines.

(22L)

Integral Calculus:

Reduction Formula. Beta and gamma functions. Area, length, volume and surface area without the use of multiple integrals.

(9L)

Infinite series:

Convergency and Divergency of infinite series. Tests for Convergence. Comparison Test, p series test, Cauchy's root test. D' Alembert's ratio test, Razabe's Test, Gauss's Test, Logarithmic and Higher logarithmic ratio test (No proof). Leibnitz's Rule for alternating series test.

(6L)

Books Recommended:

1. Higher Trigonometry. Das and Mukherjee (U.N. Dhur & Co.)
2. Differential Calculus. Pran Nath and Agarwal. Tara Publications, Varanasi
3. Integral Calculus. Das and Mukherjee (U.N. Dhur & Co.)
4. Engineering Mathematics. H.K. Dass
5. Higher Engineering Mathematics B.S. Grewal (Khanna Publishers)

Equivalent Force System and Equilibrium: Principles of statics, laws of mechanics, freebody diagram, coplanar, non-coplanar and spatial force system and conditions of equilibrium, vector representation and analysis of forces and moments, Varignon's theorem.

Structural Mechanics: Analysis of simple plane truss by method of sections and methods of joints, analysis of frames and parabolic cables, cantilever and simply supported beams with concentrated, distributed and moment loads, shear force and bending moment diagrams, concept of stress and strain.

Interfacial Friction: Friction and impending motion, static, kinetic and rolling friction, application to inclined planes, wedges, screws jacks and belts.

Kinematics and Kinetics of Particle and Rigid Bodies: Conceptual framework and vector representation of displacement, velocity, acceleration, linear and angular momentum, rectilinear and curvilinear motion in two dimensions, centroidal and non-centroidal rotation, general plane motion, Newton's laws of motion, D'Alembert's principle, equilibrium of dynamic forces.

Work and Energy: Translation and rotation of rigid body about a fixed axis, conservation of energy, energy and work equations in translation and rotational motion, virtual work.

Impulse and Momentum: Impulse force and momentum, conservation of momentum, coefficient of restitution, momentum equation. Vibrating Systems: Inertia, features of a vibrating system, free vibration, systems with single degree of freedom.

Books Recommended:

1. Kumar, Engineering Mechanics
2. Shames, Engineering Mechanics

SECOND SEMESTER

MA 2101	MATHEMATICS- II	1.0

Integral Calculus:
Operations under the sign of integration, Multiple integrals, change of order of integration, Transformation of Co-ordinates, Area, Volume and Surface area of solids using multiple integrals.

(8L)

Ordinary Differential Equations:
Linear differential equations: Bernoulli's from Exact equations, Nonlinear equations, Clairaut's form, Higher order equations with constant coefficients. Cauchy's and Legendre's differential equations. Solution of higher order equation by the change of independent variable, Method of variation of Parameters in Simple cases,
Applications to Engieering problems.
Series solution of Differential equations by the method of Frobenius.(Roots differing by non integer and equal roots).

(14L)

Algebra of Matrices:
Rank of a matrix. Consistency and inconsistency of a system of linear equations. Eigen values and eigen vectors. Cayley Hamiliton Theorem.

(3L)

Vector spaces:
Definition, examples and some simple properties. Subspaces, linear combination, linear dependence and independence, Basis and dimension. Norm of a vector, Inner Product. Cauchy-schwartz inequality, orthogonal sets. Gram-schmidt process of construction of orthogonal sets. Parallelogram law and Pythagorian theorem.

(8L)

Vector Calculus and Tensor Analysis:
Differentiation of vectors, Radial and transverse, tangential and normal acceleration of a particle moving on a plane curve. Directional derivatives, Gradient, Divergence and Curl. Expansion Identities. Vector integration. Conservative system of forces. Solenoidal and Irrotational vectors. Theorems of Green, Stoke and Gauss and their applications,
Tensors, transformation of Co-ordinates, contravariant and covariant vectors and Tensors. Rank of a tensor. Addition and multiplication of tensors. Mixed tensors Contraction.

(10L)

Books Recommended:

1. Advanced Engineering Mathematics byE. Kreyszig
2. Advanced Mathematics for Engineers By Chandrika Prasad (Prasad Mudranalaya)
3. Advanced Engineering Mathematics By H.K. Das.

MODULE – I

Introduction: Importance of Electrical Engineering in day-to-day life. Electrical elements and their classification. KCL and KVL equations. Loop current and Node voltage method. D.C. Circuits: Steady state analysis with independent and dependent sources; Series and Parallel circuits; Star-Delta conversion. D.C. Circuit Theorems: Superposition theorem; Thevenin's & Norton's theorem; Maximum Power Transfer theorem.

(12)

MODULE – II

A.C. Single-phase Series Circuits: Common signals and their waveforms. RMS and Average value. Form factor & Peak factor of sinusoidal waveform. Impedance of Series circuits. Phasor diagram. Power. Power factor. Power triangle.

(5)

MODULE – III

A.C. Single-phase Parallel Circuits: Admittance method, Phasor diagram. Power. Power factor. Power triangle.

(5)

MODULE – IV

Resonance and Q-factor, A.C. Circuit Theorems: Superposition theorem; Thevenin's & Norton's theorem; Maximum Power Transfer theorem.

(7)

MODULE – V

Three Phase Circuits: Line and Phase relation for Star and Delta connection. Power relations. Analysis of balanced and unbalanced 3 phase circuits.

(7)

MODULE – VI

Magnetic Circuits: Introduction. Series-parallel magnetic circuits. Analysis of Linear and Non-linear magnetic circuits. Energy storage. A.C. excitation. Eddy currents and Hysteresis losses.

(5)

MODULE – VII

Coupled Circuits (Dot rule), Self and mutual inductances, Coefficient of coupling.
Basic Indicating Instruments: Moving coil and moving iron type instruments.

(4)

Books Recommended:

1. Nagrath and Grabel, Basic Electrical Engineering
2. Fitzzerald and Higinbotham, Basic Electrical Engineering

MODULE – I & II

Introduction to C++ and algorithm analysis: C++ classes, C++ details, Using matrics, Mathematical background for algorithm analysis, model and what to analyze, Running Time calculations.

MODULE – III

Lists, Stacks and Queues: Abstract Data Types, The list ADT, The Stack ADT, The Queue ADT

MODULE – IV

Trees: Preliminaries, Binary Trees, The Search Tree ADT – Binary Search Trees, AVL Trees, Splay Trees, Tree Traversals, B-Trees.

MODULE – V

Hashing and Priority Queues: Model and Simple implementations, Binary Heap, Applications of Priority Queues, d-Heaps, Leftist and Skew Heaps.

MODULE – VI

Sorting: Preliminaries, Insertion sort, A Lower Bound for Simple Sorting Algorithms, Shell sort, Heap sort, Merge sort, and Quick short.

MODULE – VII

Graph Algorithms: Definitions, Topological Sort, Shortest Path Algorithms, Network Flow Problems and Minimum Spanning Tree.

Text Books:

1. Mark A. Weiss – Data Structures & Algorithm Analysis in C++, 2nd Edition, Pearson Education, New Delhi – 2002.

Reference:

1. Gregory L. Heilean – Data Structures Algorithms, and Object Programming, Tata McGrow Hill, New Delhi – 2002.
2. Adam Drozdek – Data Structures and Algorithms in C++, Thomson Learning (Vikas Publishing House) New Delhi – 2001.
3. John R. Hubbard – Data Structures with C++, Tata McGraw Hill, New Delhi, 2004

MODULE– I

Environmental Awareness: Multidisciplinary nature of environmental Science, Definition, scope , importance and need for public awareness.

(2)

MODULE– II

Ecology and Environment: concept of an ecosystem ,structure and function of an ecosystem, producer ,consumer and decomposer, energy and nutrient flow biogeochemical cycles, food chain ,food web, ecological pyramid.

(3)

MODULE– III

Environmental Pollution : Segments of environment, sources, pathways and fate of environmental pollutants, causes of environmental pollution , physical ,chemical and biological transformation of pollutants , population explosion, environment and human health, human rights, value education ,women and child welfare.

(5)

MODULE– IV

Air Pollution: various segments of atmosphere and their significance,classification of air pollutants, toxic effects, sampling and analysis, stationary and mobile emission, sources and their control, photochemical smog ,sulphurous smog, green house effect, global warming, ozone depletion, Air (prevention and control of pollution) Act.

(10)

MODULE– V

Water Pollution: Water resources ,sources of water pollution ,various pollutants, their toxic effect, potability of water , municipal water supply , disinfection, characteristics of waste water, primary and secondary waste water treatment, BOD and COD measurement and their significance ,rain water harvesting ,water shed management,Water (pollution and control) Act.

(12)

MODULE– VI

Natural Resources and Biodiversity: Renewable and non renewable resources, Forest resource, consequences of deforestation, floods and draughts, equitable use of resources for sustainable development, Dams benefits and problems, Biodiversity: ecosystem diversity , threats to biodiversity, conservation of biodiversity**.**

(4)

MODULE– VII

A brief introduction to Noise Pollution, Soil Pollution, Solid Waste Management.

(4)

Books Recommended:

1. Sharma and Kaur, Environmental Pollution
2. De, Environment Chemistry

MODULE – I

Special Theory Of Relativity

Postulates, Galilean transformations, Lorentz transformations, length contraction, time dilation, velocity addition, mass change and Einstein's mass energy relation. (AB: 1.1,1.2,1.4,1.7,1.8,1.9, and Appendix to chapter-1

[6]

MODULE – II

Quantum Mechanics:

Planck's theory of black-body radiation (AB: 2.2, 9.5, 9.6), Compton effect (AB: 2.7), wave particle duality, De Broglie waves, Davisson and Germer's experiment(AB:2.4, 3.1, 3.2, 3.3, 3.4, 3.5), uncertainty principle(AB:3.7,3.8,3.9), physical interpretation of wave function and its normalization(AB:3.2), expectation value(AB:5.4).

[8]

Schrodinger equation in one dimension(AB:5.2), solutions of time-independent Schrodinger equation for free particle(AB:3.6, 5.5, 5.6), particle in an infinite square well, potential barrier and tunneling(AB:5.7, 5.8), hydrogen atom (qualitative)(HRW:40-8).

[8]

MODULE – III

Statistical Physics And Thermodynamics:

Elementary ideas, comparison of Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics (AB: 9.1, 9.2, 9.3, 9.4).

[4]

Zeroth law, first law, second law, entropy, heat transfer, steady state one-dimensional heat conduction [(HRW:19-2, 19-9, 21-3, 19-11),(SS:14.2, 14.7)].

[6]

MODULE – IV

Lasers And Applications:

Emission of light by atoms, spontaneous and stimulated emission (AB: 4.9, and AG: 23.1), Einstein's A and B coefficients, laser: population-inversion (AG: 23.4), properties of laser radiation, Ruby & He-Ne lasers, applications of lasers (AB: 4.9) and AG: 23.1), elementary ideas of holography (AG: 18.1) and fiber optics (AG: 24.1-24.3).

[8]

MODULE – IV

Nuclear Physics:

Nuclear forces, binding energy, liquid drop model (AB: 11.1-11.6), fission, nuclear reactors, fusion, energy processes in stars, controlled thermonuclear reactions (AB: 12.9-12.12).

[5]

Text Books:

1. Arthur Beiser, Concepts of Modern Physics, 5th edition, Tata McGraw Hill, 1997.
2. Ajoy Ghatak, Optics, 2nd edition, Tata McGraw Hill, 1997.

Reference Books:

1. Jasprit Singh, Modern Physics for Engineers, John Wiley & Sons, 1999.
2. Kenneth Krane, Modern Physics, 2nd edition, John Wiley & Sons, 1998.
3. Wehr, Richards and Adair, Physics of the Atom, 4th edition, Addison Wesley.

THIRD SEMESTER

EC 3101	BASIC ELECTRONICS	1.0

MODULE – I

Introduction: Importance of Electrical Engineering in day-to-day life. Electrical elements and their classification. KCL and KVL equations. Loop current and Node voltage method. D.C. Circuits: Steady state analysis with independent and dependent sources; Series and Parallel circuits; Star-Delta conversion. D.C. Circuit Theorems: Superposition theorem; Thevenin's & Norton's theorem; Maximum Power Transfer theorem.

(12)

MODULE – II

A.C. Single-phase Series Circuits: Common signals and their waveforms. RMS and Average value. Form factor & Peak factor of sinusoidal waveform. Impedance of Series circuits. Phasor diagram. Power. Power factor. Power triangle.

(5)

MODULE – III

A.C. Single-phase Parallel Circuits: Admittance method, Phasor diagram. Power. Power factor. Power triangle.

(5)

MODULE – IV

Resonance and Q-factor, A.C. Circuit Theorems: Superposition theorem; Thevenin's & Norton's theorem; Maximum Power Transfer theorem.

(7)

MODULE – V

Three Phase Circuits: Line and Phase relation for Star and Delta connection. Power relations. Analysis of balanced and unbalanced 3 phase circuits.

(7)

MODULE – VI

Magnetic Circuits: Introduction. Series-parallel magnetic circuits. Analysis of Linear and Non-linear magnetic circuits. Energy storage. A.C. excitation. Eddy currents and Hysteresis losses.

(5)

MODULE – VII

Coupled Circuits (Dot rule), Self and mutual inductances, Coefficient of coupling.
Basic Indicating Instruments: Moving coil and moving iron type instruments.

(4)

Text Books:

1. Basic Electrical Engineering, Fitzgerald, Hinginbotham
2. Basic Electrical Engineering I.J. Nagrath and D.P. Kothari, 2nd Edition, TMH, Delhi.

Reference Books:

1. Electric circuits- Schaum Series
2. Electrical Engineering- Del Toro.
3. Basic Electrical Engineering- Mittle.

MA 3101	MATHEMATICS- III	1.0

Special Functions:
Bessel's equation: solution and Bessel's function of the first kind, Recurrence relations. Orthogonality of Bessel's Functions. Generating function and Bessel's integral. Legendre's equation: solution and Legendre's polynomials, Rodrigue's Formula. Orthogonarity relations. Generating function and recurrence relation. Definition of Hankekl's function. Elliptic Integral of the first and second kind. Jacobi's form of elliptic integrals.

(8L)

Complex Variables:
Continuity, differentiability and analyticity of a function of a complex variable, Cauchy Riemann differential equations in Cartesian and polar forms. Harmonic functions, Bilinear and conformal transformations. Complex integration, Cauchy's integral theorem and formula. Derivatives. Taylor's and Laurent's Series. Poles and Singularities. Cauchy's Residue Theorem. Contour integration (Poles on real axis excluded)

(13L)

Partial differential equations:
Formation of partial differential equations. Lagrange's first order linear equations. Non linear equations. Higher order differential equations with constant Co-efficients. Non homogeneous equations: solution by separation of variables. Boundary value Problems. wave equation in one dimension and its solution. Derivation of one dimensional heat equation and its solution.

(10L)

Fourier Series and Fourier Transform:
Periodic functions Existence conditions Euler's formulae. Half range series. Fourier series of functions with arbitrary period.
Fourier Integral Formula, Fourier Transform, Inversion Theorem, Fourier sine and cosine transforms and inversion formulae, Linearity property, Convolution or Faltung theorem. Relationship between Fourier and Laplace transform. Finite Fourier Transforms. Heaviside, Unit step function and Dirac Delta Function

(10L)

Statistics:
Mean and variance. Moments. Concept of Random variable. Probability density and Distribution functions Problems, Elements of error analysis

(4L)

Books Recommended:

1. Engineering Mathematics – E. Kreyszig
2. Advanced Engineering Mathematics – C. Prasad
3. Fourier Transforms – I.N. Sneddon

MODULE – I

Introduction to signals and systems: Definition, Basis of classification, Representation of common signals and their properties, System modeling

(4)

MODULE – II

Analogous System: Introduction, D Alembert's Principle, Force-voltage and force-current analogies, Electrical analogue of mechanical, Hydraulic and thermal systems.

(5)

MODULE – III

Fourier Transform Method: Introduction, Fourier transform pair, Amplitude spectrum and phase spectrum of signals, Sinusoidal transfer function.

(3)

MODULE – IV

Laplace Transform Method: Introduction, Laplace transform pair, Laplace transformation of common functions, Gate function, Step function and impulse function, Laplace theorems shifting, initial value, final value and convolution theorems.
Inverse Laplace transform by partial fraction expansion and convolution integral method.

(12)

MODULE – V

System Analysis: System Analysis by Laplace Transform method, System response. Natural, forced, transient and steady state responses. Transfer function and characteristic equation, Superposition integral, Concept of poles and zeros, Nature of system response from poles and zeros.

(6)

MODULE – VI

System Stability: Concept of stability, Types, Necessary and sufficient conditions, Routh Hurwitz stability criterion, Limitations and its applications to closed loop systems.

(4)

MODULE – VII

State-Space Concept: Introduction, Definition: State, State variable, State vector and state space, State space representation, Derivation of State model from transfer function, Bush form and diagonal canonical form of state model, Non-uniqueness of state model, Derivation of transfer function from state model, Transition matrix and its properties, Solution of time invariant state equation.

(6)

Text Books:

1. Analysis of Linear Systems – D.K.Cheng.
2. Control System Engineering – Nagrath & Gopal
3. Control System – A. Anand Kumar

Reference Books:

1. Networks and Systems – D. Roy Choudhury
2. Signals and Systems - Basu & Natarajan

PL 3101	INTRODUCTION TO POLYMER ENGINEERING	1.0

MODULE– I

Basic concepts, historical developments, definitions, classifications, anomalous behavior of polymer, effective on polymer.

(5)

MODULE– II

Transition in polymers: melting, glass transition and brittle temperatures

(5)

MODULE– III

Molecular weight and molecular weight distribution number average, weight average, viscosity average & Z-average molecular weight and their relationships.

(8)

MODULE– IV

Compounding of polymer, effect of additives, filler, plasticizer, cross linker, stabilizers, blowing agents, coupling agents etc.

(7)

MODULE– V

Polymer Processing: injection moulding extrusion, compression, blow moulding, vacuum and pressure forming laminates and composites.

(7)

MODULE– VI

Polymer product and application: plastic, rubber, fiber, adhesives, paints and lubricants.

(8)

MODULE– VII

Special application of polymer: conductive, magnetic, optical, photoresponsive, smart polymer and polymeric gel.

(5)

Text Books:

1. Text book of Polymer Science: Billmeyer F.W. 3rd Edn., Willey Inter Science, 1984
2. Principles of Polymer system: Ferdinand Rodriguez, Taylor & Francis, 1996

MODULE – I

Introduction To Crystallography:

Crystal structures, Space lattice, Symmetry elements, Unit cells, Crystal systems, Packing factors, Miller indices, Single crystals, Polycrystalline materials (WDC 3.1-3.14). Distance between parallel planes, X-ray diffraction & Bragg's law, Laue method, Power Method (WFS 3.11).

[5]

MODULE – II

Imperfections And Strengthening Mechanism In Solids:

Types of imperfections, Point defects (WDC 4.1-4.3). Dislocations: Edge dislocation & Screw dislocation, Burger's vector, Concepts of dislocation density (WDC 4.5), Surface defects (WDC 4.6), Volume defects (WDC 4.7), vibrational defects (WDC 4.8).

[4]

MODULE – II

Phase Rules:

Phases (WDC 9.3), Phase Equilibria, Single component systems (WDC 9.5). Binary phase diagrams(WDC 9.6), Microstructural changes during cooling, The Lever rule and its applications (WFS 8.4), Gibbs phase rule (WDC 9.7-9.8, WFS 8.2). Glass transition (WDC 13.8).

[4]

MODULE – III

Mechanical Properties:

Engineering stress, Engineering strain, stress-strain behaviour, Elastic deformation (WFS 6.2, 6.3). Atomic view of elasticity, Anelasticity, Slip, Slip systems (WDC 7.4), Resolved shear stress (WDC 7.5), Plastic deformation of single and polycrystalline materials (WDC 7.6, WFS 6.5), Strain hardening (WDC 7.10). Recovery (WDC 7.11), Recrystallization, Cold working & Hot working (WDC 7.12, WFS 6.8). Grain Growth (WDC 7.13), Introduction to Fracture, Fatigue and Creep (WDC 8.2.-8.16, WFS 6.11).

[8]

MODULE – IV

Electrical And Magnetic Properties:

Basic concepts and types of polarization, A.C. effects, Ferro-electricity, Piezo electricity, Ferro and piezo electric materials (WDC 18.24-18.25).

Free electron theory of metals, Band theory of solids, Intrinsic, Extrinsic & compound semiconductor, conductivity, mobility, Temperature dependence of conductivity & carrier concentration (WDC 18.1 – 18.13). Superconductors: elementary introduction, High T_C superconductors (WDC 20.11).

Dia, Para and Ferromagnetism, Antiferromagnetism, Ferrimagnetism, Influence of temperature, Magnetic domains & hysteresis, Magnetic materials, Magnetic storage devices, Memory materials (WDC 20.1 -20.10).

[10]

MODULE – VI

Ceramic, Glasses, Polymers And Composites:

Common Refractory: Materials, Portland cement composition and its grades (WDC 16.2).

Glasses: Types of glasses, Glass ceramics (WFS 10.9)

Polymers: Polymer classification and properties, Polymer applications, Cable, Insulation, Optical Fibre (WDC 14.1-14.4, 15.2-15.5, 15.10-15.13). Smart polymers for electrical and electronic applications, Conducting polymers (WDC 18.17).

Composites: Fibre reinforced composites (WFS 13.3), Influence of fibre length & orientation (WDC 16.4), Whiskers, Various fibre reinforced composites, plastic and glass fibers (WDC 16.6).

[10]

MODULE – VII

Introduction To Nanotechnology:

Basic concepts of nanotechnology, Nanomaterials: Fabrications & Applications. [**Nanotechnology:** M Ratner & D. Ratner (Pearson Education Publication)]

[4]

Texts Books:

1. W. D. Callister, Materials Science and Engineering: An Introduction, John Wiley, 6th Edition, 2003. [WDC]
2. W. F. Smith, Principles of Materials Science and Engineering, McGraw Hill International, 1986. [WFS].

References:

1. The Structure and Properties of Materials, Vol. –I,
2. Mofatt, Pearsall and Wulf, Vol. –III ,
3. Hayden , Mofatt and Wulf, Vol. –IV,
4. Pease, Rose and Wulf, Wiley Eastern. (2)
5. Physical Properties of Materials, M. C. Lovell, A. J. Avery, M. W. Vernon, ELBS.

FOURTH SEMESTER

PL 4101	BASIC POLYMER CHEMISTRY	1.0

MODULE – I

Structure, bonding and reactivity, Aromaticity, Inductive effect, Hyperconjugation, Conjugation and Resonance Energy of activation and transition state. Aliphatic and aromatic nucleophilic substitutions, Aliphatic and aromatic electrophilic substitutions.

(8)

MODULE – II

Addition and elimination reactions, Carbocations, Carbanions, Free radicals, Carbenes, Nitrenes

(10)

MODULE – III

Optical activity. Stereochemistry and stereospecific reactions. Asymmetric Synthesis. Nomenclature (D/L and R/S system)

(4)

MODULE – IV

Rearrangements in polymer synthesis, Oxidations and reductions

(4)

MODULE – V

Heterocyclic compounds (Pyridine, Pyrrole, Thiophene, Furan)

(4)

MODULE – VI

Co-ordination chemistry (Crystal Field Theory, Molecular orbital theory). Catalysts: Type and example, characteristics of catalytic reaction, Theory of mechanism of catalysis, acid base catalysis, Ziegler Natta, Metallocene, Cationic and anionic catalysts for polymer synthesis, Polymer Catalyst,

(8)

MODULE – VII

Principles of Absorption and Emission Spectroscopy, IR, Raman, UV-Visible, NMR, ESR and Mass Spectroscopy studies of polymeric Compounds

(7)

Text Books:

1. Organic Chemistry: Morrison and Boyd R.N. Prentice Hall.
2. Organic Chemistry: I.L. Finner, 6th edition, vol 1 & 2
3. Principles of Polymer System: Ferdinand Rodriguez, fourth edition Taylor & Francis 1996
4. Principles of Polymer Chemistry: A. Ravve, 2nd edition
5. Analytical Chemistry: S. Usharani,
6. Organic Reaction Mechanism: V.K.Ahluwalia & Parasar

PL 4103	MACROMOLECULAR SCIENCE- I	1.0

MODULE– I

Polymer structure, Conformation and isomerism of Polymer, Nomenclature of polymer.

(3)

MODULE– II

Structure- property (optical, thermal, mechanical, electrical etc.) relationships in polymer **systems**- Chemical structures of repeat units, nature of end groups, structural defects.

(6)

MODULE– III

Homopolymers vs, co-polymers, thermo mechanical treatment and changes in orientation (influence of physical structure).

(5)

MODULE– IV

Polymer crystallinity and semi-crystallinity, amorphous polymers, cross-linking and its effects, effect of polarity and rigid groups or Flexible linkages etc.

(6)

MODULE– V

Polymer Solutions: Criteria for polymer solubility. Conformations of polymer chains in solution. Concept of viscosity & surface tension and as applied to polymeric system.

(7)

MODULE– VI

Colloids and Interfacial science: Preparation, properties and application of colloidal system in study of molecules, Micro emulsions, Emulsions, Suspensions. Thermodynamics of interfaces. Surfactants and its properties.

(8)

MODULE– VII

Molecular weight determination by Boiling point elevation, vapour pressure osmometry, osmosis, light scattering, Gel permeation chromatography, viscometry, sedimentation and End group analysis method.

(10)

Text Books:

1. Text book of Polymer Science: Billmeyer F.W., 3rd Ed. Willey Inter. Science, 1984.
2. Principles of Polymer system:Ferdinand Rodriguez, 4th Ed., Taylor & Francis, 1996.
3. The Element of Polymer Science & Engineering: Rudin.
4. Structural Investigation of Polymer: Bodor G., 1st Ed., Ellis Harwood Ltd., 1991.

PL 4105	CHEMICAL ENGINEERING- I	1.0

MODULE– I

Industrial stoichiometry: Units and dimensions, conversion of units. Use of molal units. Material balance without chemical reaction, with chemical reaction and Recycling, Energy balance.

(10)

MODULE– II

Particle size analysis, Principles of size reduction: Industrial mills, power requirement, Size reduction of Plastics. .Industrial screening, Screen effectiveness.

(7)

MODULE– III

Fluid- particle mechanics: Free and hindered settling. Classifiers and clarifiers. Centrifugal separators. Separation of mixed plastics. Hydrocyclones. Theory of filtration. Industrial filters and their design.

(6)

MODULE– IV

Gas solid systems: Settling chambers, centrifugal settling, ESP, Scrubbers, Filters. Beneficiation processes such as forth flotation, magnetic separation, electrostatic separation. Thickeners, tabling, Jigging etc. Application in separation of mixed plastics.

(5)

MODULE– V

Measurements of Flow of fluids: Orifice meter, Rotameter, Venturimeter, Magnetic meters,Pipe fittings and valves.

Fluid moving machinery and different types of pumps: Centrifugal pumps, Fans, Blowers, Compressors.

Agitation and mixing of fluids: Agitation equipment, Flow number, Power consumption, Blending and mixing.

(7)

MODULE– VI

Storage and transportation of solids. Properties of Bulk Materials. Bulk Density, coefficient of Internal Friction. Pressure distribution in Hopper. Janssen Equation.

(5)

MODULE– VII

Mixing of pastes & dry solids. Mixing Mechanisms: Dispersive and distributive mixing. **Characterization of mixtures:** Mixing Index, scale of segregagton, Interfacial area, striation thickness etc. Equipment. with special reference to mixing of plastic melts. Power requirement.

(5)

Text Books:

1. Himmelblau, D.M., "Basic Principles and Calculations in Chemical Engineering", Prentice Hall of India, 1997.
2. McCabe, W.L., Smith, J.C., and Harriott, P., "Unit Operations of Chemical Engineering", Fifth Ed., McGraw Hill, 1993.
3. Transport proceses and Separation Process Principles, C.J.Geankoplis, Prentice Hall of India, 4th Ed. 2004.
4. Principles of Polymer Processing, Tadmor, Z and Gogos, C.G., John Wiley and Sons, 1982.

PL 4107	HEAT TRANSFER	1.0

MODULE– I

Conduction: Derivation of basic heat conduction equation in rectangular co-ordinates, expression in cylindrical and spherical co-ordinates. Steady state conduction in one dimension for plane wall, cylinders, hollow spheres.

(8)

MODULE– II

Unsteady state conduction: lumped heat capacity systems, Infinite plate, semi infinite solid, charts for transient heat transfer and their uses. Heat Transfer analysis in Polymer Processing Operations.

(6)

MODULE– III

Convection: Natural and forced convection, heat transfer coefficient, empirical equations to calculate heat transfer coefficient, Heat Transfer fluids.

(8)

MODULE– IV

Heat exchanger design concept LMTD and effectiveness. Types of heat exchangers, double pipe, shell and tube. Extended Surface Heat Exchangers, Plate type, Spiral heat exchangers etc. Heat Exchange in Injection Moulds

(6)

MODULE– V

Heat transfer in batch and continuous Agitated vessels. Polymerization Reactors.

(5)

MODULE– VI

Radiation: Stefan Boltzmann law, Kirchoff's law, Radiant heat exchange between black and gray bodies. Radiation from gas and vapour (preliminary). Heat loss to atmosphere. Lagging of pipes, Optimum lagging thickness.

(6)

MODULE– VII

Heat transfer with phase change: boiling and condensation. Evaporator: Classification and design: applications in Suspension and Emulsion Polymerization Reactors.

(6)

Text Books:

1. Holman, J.P., Heat Transfer, Mc Graw Hill
2. Process Heat Transfer: Kern D.Q., McGraw Hill.
3. Unit Operations of Chemical Engineering: McCabe, W.L., Smith, J.C., Harriot, P., McGraw Hill, 1993.
4. Kothandaraman, C.P. and S. Subramanyan, Heat and Mass Transfer Data Book. New Age International

Computational Errors & Approximations:
Numbers & their accuracy, Errors & their Analysis, Errors in a series approximation.

(2L)

Solution of Algebraic & Transcendental Equations with Algorithms:
Graphical Method, The bisection method, The method of false position, Newton-Raphson Method & its rate of convergence. Solution of Non-linear equations in two variables by Newton-Raphson method & Bairstow's method for complex roots.

(6L)

Solutions of System of Linear Algebraic Equations with Algorithm:
Direct Methods: Gaussian Elimination method. Gauss-Jordan Method & Decomposition method, Iteration methods: Jacobi & Gauss-Seidal Methods.

(6L)

Interpolation:
Finite differences, Newton's forward and backward interpolation formula, Gauss's Central Difference formula Sterling's & Bassel's interpolation for unevenly spaced points, Newton's general interpolation formula with divided differences.

(7L)

Curve Fitting Cubic Splines and Approximation:
Principle of least squares, Curve fitting: Fitting a straight line. Polynomial of second degree, Data fitting with cubic splines.

(3L)

Numerical Differentiation & Integration:
Differentiation by using Newton's forward. Backward and central difference formulas, Differentiation by cubic spline method. Integration by Trapezoidal Rule, Simpson's 1/3' rd Rule. '3/8th Rule.

(7L)

Computational Algorithm:
Solution of initial value problems of first order: Picard's method Taylor's series, Euler's method, Runge-Kutta method, Milne-Simpson method, Finite Difference algorithms for solutionj of a two point, Second order boundary value problem.

Finite Difference:
Analogues of Partial Differential equations, Use jof standard five point algorithms and diagonal five point algorithms in solution of Laplace equation & Parabolic equations.

Suggested Books:

1. Introductory method of Numerical analysis – Prentice – Hall of India New Delhi, S.S. Sastry
2. Computer Oriented Numerical Methods – Prentice-Hall of India – V. Rajaraman.
3. Finite Differences & Numerical Analysis – S. Chand & Co. Ltd. New Delhji – H.C. Saxena.
4. Introduction to Numerical Analysis – Addision – Wesley Publishing Company – Froberg.)

FIFTH SEMESTER

PL 5105	CHEMICAL ENGINEERING- II	1.0

MODULE- I

Nature and theory of mass diffusion. Molecular diffusion in gases, liquids and porous solids. Steady state and unsteady state diffusion. Diffusivity, solubility and permeability in polymer systems. Devolatalization of polymer melts.

(6)

MODULE- II

Principles of gas absorption. Two film, penetration and surface renewal theories. Individual and overall mass transfer coefficients. Design of packed and tray towers.

(5)

MODULE- III

Distillation principles: Batch, continues flash, steam, vacuum, molecular, azeotropic and extractive distillation. Mc Cabe Theiele method of theoretical plate calculation.

(6)

MODULE- IV

Liquid Extraction, phase diagram, single and multi stage calculations. Extraction with reflux. Supercritical liquid extraction. Extraction towers and other equipment. Leaching-principles and equipment.

(6)

MODULE- V

Crystallization: Nucleation, crystal growth, solubility curve, yield calculation,.Crystallizers and their design. Crystallization in Polymer systems. Avrami equation.

(6)

MODULE- VI

Drying: Classification and selection of industrial dryers. Dryer design.
Humidification: Air conditioning, cooling tower, refrigeration.

(6)

MODULE- VII

Adsorption and Ion Exchange: Principles, equipment and design. Ion Exchange resins.
Membrane Processes: Principles, Equipment and Design principles for Reverse osmosis, ultra filtration, electrodialysis etc . Polymeric membranes for various applications.

(10)

Text Books:

1. Mass Transfer Operations: Treybal R.E., Mc Graw Hill, 1981
2. Unit Operations of Chemical Engineering: Mc Cabe W.L.and Smith J.C., Mc Graw Hill. 5th Ed. 1993
3. Transport proceses and Separation Process Principles, C.J.Geankoplis, Prentice Hall of India, 4th Ed. 2004
4. Polymer Processing Principles and Design. Donald G. Baird, Dimitris I. Collias, John Wiley & Sons, 1998

PL 5101	POLYMER PROCESSING- I	1.0

MODULE- I

Injection moulding – Moulding cycle. Machine construction – barrel, screw, clamping system, nozzles. Machine ratings, Basic mould construction – classification, sprue runner gate systems, mould cooling, ejection. Effect of material properties and process variables on product quality. Shrinkage, orientation, residual stress. Part cooling analysis.

(10)

MODULE- II

Mould filling simulation. Newtonian fluid into disc cavity, runner, cavity combination

(8)

MODULE- III

Special injection moulding techniques: lost core process, Push-pull process, in mould decoration/lamination, Gas assisted injection moulding, Multicomponent injection moulding, Insert/Outsert process, Thermoplastic foam injection moulding. Reaction Injection moulding, Powder Injection Moulding, microinjection moulding etc.

(6)

MODULE- IV

Compression moulding and Transfer moulding: Moulding process. Equipment and auxiliary equipment, moulding materials and properties of materials relevant to moulding process. Moulding process cycle. Effect of process parameters and moulding design on product quality. Process defects and their remedies.

(6)

MODULE- V

Thermoforming: Classification, tooling, machine, heating arrangement, in-line thermoforming, selection of materials, Effect of material properties and process variables on product quality, applications, trouble shooting. Estimation of part thickness.

(6)

MODULE- VI

Rotational moulding process, Principles, materials, applications, methods and equipment.

(6)

MODULE- VII

Casting, Foam process, Manufacture of flexible and rigid foams.

(3)

Text Books:

1. Principles of Polymer Processing, Tadmor, Z and Gogos, C.G., John Wiley and Sons, 1982.
2. Plastics: Product Design and Process Engineering, Belofsky, H., Hanser Pub. 1995.
3. Fundamentals of Polymer Processing, Middleman, Mc Graw Hill, 1979.
4. Rotational MouldingTechnology, Roy Crawford and J.L.Throne, William Andrew publishing, 2002
5. Thermoforming, J.L.Throne,Hanser, 1987

PL 5103	MACROMOLECULAR SCIENCE- II	1.0

MODULE- I

Principles of polymerization: Functionality principle & its scope and limitations.

(2)

MODULE- II

Principles of condensation polymerization, kinetics, chain length regulation and control, molecular weight distribution, Carothers Equation: its scope and limitation, bifunctional systems, polyfunctional systems.

(8)

MODULE- III

Principles of addition/ chain growth polymerization, distinction between chain growth and step growth polymerization. Mechanism and kinetics of chain growth polymerization - initiation, propagation and termination, End groups for (a) free radical & (b) Ionic [(i) cationic (ii) anionic (iii) co-ordination] polymerization and distinctive & common features between them.

(8)

MODULE- IV

Chain transfer, inhibition and retardation, control of molecular weight, branching effects of addition/chain growth polymerization.

(8)

MODULE- V

Co polymerization: Principle and Industrial practice. Importance of co-polymerization, random, alternate, graft & block copolymers.

(10)

MODULE- VI

Polymer Degradation: (Thermal, Mechanical, Photo degradation, Mechanochemical, Oxidative, ultrasonic degradation). Polymer reactions

(5)

MODULE- VII

Polymerization techniques: Bulk, Suspension, Emulsion, Solution polymerization.

(4)

Text Books:

1. Text book of polymer Science: Billimeyer F.W., 3rd Edn., Wiley Interscience, 1984
2. Principles of polymerization: G. Odian, 2nd Edn. Wiley Interscience New York, 1981
3. Fundamentals of Polymer Science: Kumar Anil & Gupta R.K. Mc Graw Hill, 1998.
4. Principles of Polymer Systems, Rodriguez, F, Talyr & Francis, 4th Edn., 1996

PL 5107	STRENGTH OF MATERIALS	1.0

MODULE- I

Two dimensional state of stress at a point, Complementary shear stress, Principal stresses, Graphical representation of stress.

(6)

MODULE- II

Two dimensional state of strain at a point, Principal strains, Graphical representation of strain,Strain rosettes.

(6)

MODULE- III

Distribution of bending stress and shear stress in the Cross-section of beams

(6)

MODULE- IV

Differential equation of the elastic curve-Deflection of beams by double integration method - Area moment theorems - Application to simply supported, Cantilever and overhanging beams. Deflection due to shear

(9)

MODULE- V

Strain energy for axial load, bending and torsion. Castigliano's theorem- Applications.
Columns - Euler's theory for different end conditions - Rankine's Formula.
Theories of elastic failure: Introduction, Significance and comparison of various theories Equivalent bending moment and equivalent torque.

(6)

MODULE- VI

Torsion of circular shaft and power transmitted by the shaft. Combined bending and torsion on circular shaft-Equivalent B.M. and Equivalent Twisting moment

(6)

MODULE- VII

Fatigue and Creep: Introduction, various types of cyclic loading, S-N diagram. Endurance limit and fatigue strength, effect of mean stress on endurance limit. Fatigue under combined stresses.
Creep: Introduction, Creep test and creep curves, Presentation of creep data.

(6)

Text Books:

1. Strength of Materials - Timoshenko.
2. Strength of Materials - Singer.

MA 5003	FINITE ELEEMENT METHOD AND STATISTICS	1.0

MODULE- I

mean, Median and Mode, measure of dispersion, correlation and regression discrete and Random variables, probability and density and distribution functions, Moment generating and characteristic functions, cumulants.

(6)

MODULE- II

Standard distributions, binomial, Poisson and normal distributions, small sample and large sample, test concerning proportions, means, standard deviations.

(6)

MODULE- III

Test based on Chi-Square, 2x2 contingency table, Goodness of fit and test of independence Anova Test (one way and two way).

(6)

MODULE- IV

Introduction to quality control, Control chart, X-Chart, R-Chart, d-Chart, p-Chart and c-Chart, Product control and Process Control.

(4)

MODULE- V

Elements of calculus of variations, Euler lagrange differential equations, simple applications, brachistochrone problem, functional, Rayleigh Ritz method, weighted residual method and Galerkin method.

(6)

MODULE- VI

Fundamental concept, importance and area of application, basic steps, variational formulation and approximation, variational method of Approximation, variationa formulation of boundary value problems, elements and interpolating function, basic element shapes, types, types of node, degrees of freedom, interpolating polynomial.

(7)

MODULE- VII

Finite element analysis of one dimensional problems, second and forth order equations, descritization, derivation of element equation, assembly of element equation, application to heat transfer, polymer processing, fluid mechanics, mechanics, bending of beams.

(10)

Text Books:

1. Business statistics
2. Introduction to mathematical statistics – Mood Grayhill and Boes, Tata mc Graw Hill.
3. Finite element analysis – C.S. Krishnamoorthy, Tata Mc Graw Hill Publishing Co. Ltd.
4. Computer modeling for polymer processing – Charls L. tucker III, Hanser publishers.

PL 5109	POLYMER TECHNOLOGY- I	1.0

MODULE- I

Additives for Plastics: Definition, classification, mechanism of action, method of incorporation of: fillers, plasticizer, stabilizer, (antioxidants/ ozonants)

(5)

MODULE- II

Colorants, mould releasing agents, cross linking agents, blowing agents, antistatic agents, biocides, coupling agents, flame retardants, antiblock agents,

(5)

MODULE- III

Nucleating agents, toughening agent, flow promoters, slip additives, extenders, antistatic agents, and pigments, dyes.

(5)

MODULE- IV

Manufacturing process with emphasis on flow sheet & process alternatives, processing application, major engineering problems & economics, manufacturers in India of the following polymers: Thermoplastics: PE (LDPE, HDPE, XLPE, UHMHDEP), chlorinated PE, PTFE

(10)

MODULE- V

PS, PVC, PVOH, Acrylics, polyvinyl ester

(5)

MODULE- VI

copolymers– LLDPE, EVA, EPDM, ABS, SAN, ethylene – ethylacrylate ionomers.

(5)

MODULE- VII

Thermosets: Phenolic resins, aminoplasts, alkyl, & aryl epoxies, polyurethanes, silicones.

(10)

Text Books:

1. Plastics materials: Brydson J.A., 3rd Edn., Butter worth, Woburn 1975
2. Plastics Engineering Hand Book: Frados J. Society of plastic & Industruy. Inc. 4th Edn., Van Nostrand, N.Y. 1976
3. Shreve's chemical process Industries, George T. Sustin, Mc Grow Hill.
4. Unit process in Organic synthesis, Groggins, P.H. Mc Grow Hill.
5. Hand Book of Plastic Testing Technology, Vishu Shah, Wiley Inter Science.

SIXTH SEMESTER

PL 6101	POLYMER PROCESSING- II	1.0

MODULE- I

Extrusion hardware: Extruder Classification - Screw, disk, drum, Ram, Drives, Bearing, Screw, Barrel, Breaker Screen, hopper, Screw geometry, heating & cooling systems. Dies for sheet, pipe, blown film, wire coating

(8)

MODULE- II

Process analysis: Solids conveying, plasticating, melt conveying (Newtonian/Non Newtonian), Power consumption, Optimal, Design. Flow through dies. Extrudate Swell. Instabilities - shark skin, melt fracture. Polymer degradation

(8)

MODULE- III

Post Extrusion machinery and product testing: Pipe/tube, blown film, co-extruded films, wire coating, sheet, cast film, oriented films and tapes, monofilaments etc.

(10)

MODULE- IV

Compounding of Polymer: Principles and practices of compounding of polymers, Dispersive and distributive mixing.

Characterization of mixtures: Mixing Index, scale of segregation, Interfacial area, striation thickness etc. Equipment Mixing of polymers, Single screw extruder with mixing sections, twin screw extruders, mixing rolls, internal mixers, batch mixers, motionless mixers etc.

(5)

MODULE- V

Blow moulding: Machinery and process details: injection blow moulding, extrusion blow moulding, stretch blow moulding. Parison control. Choice of material. Product testing.

(6)

MODULE- VI

Calendering: type calenders. Calender heating and temperature control, cross axes, roll bending, Material for calendering sheet and films. Process analysis of calendering and roll mixing.

(4)

MODULE- VII

Joining of plastics: Welding, adhesive bonding, mechanical fastening. Hot stamping, Metalizing. Machining.

(4)

Text Books:

1. Polymer Extrusion, Chris Rauwendaal, Hanser, 1994.
2. Plastics Product Design and Process Engineering, H. Belofsky, Hanser, 1995.
3. Blow Moulding Handbook, Rosato, D.V. and Rosato D.V., Hanser, 1989.
4. Principles of Polymer Processing, Tadmor, Z and Gogos, C.G., John Wiley and Sons, 1982.
5. Plastic Extrusion Technology, Hensen, Henser, 1997.

PL 6103	DIE MOULD DESIGN & FABRICATION	1.0

MODULE- I

Injection Moulds: Types of Mould. Two and Three plate Mould, Split cavity mould. Basic mould elements. Computation of number of cavities, cavity layout. Selection of parting line. Feed system, Cooling system, Ejection system, Mould venting, Mould Alignment, Lifting and clamping, Mechanical Design, Strength of cavities, Support pillar, screws in molds.

(12)

MODULE- II

Special Moulds: Split moulds, Mould for threaded components, Hot runner mould, Limits and tolerances of mould components. Mould economics.

(4)

MODULE- III

Compression Moulds: Types of compression moulds, loading chamber design, heater types & calculation, pressure pad area calculation. Transfer moulds: Types of transfer molds, pot calculation, Feed system, Ejection method, cull pick up.

(4)

MODULE- IV

Extrusion dies with different exit cross sections: Circular, slit, annular, profile.

(6)

MODULE- V

Blow moulds: Parting line, neck, pinch off, flash trimming, venting, cooling. Parison die and mandrel. Moulds for Rotomoulding and thermoforming.

(5)

MODULE- VI

Mould fabrication, steels for moulding tools and their treatment. Outline of Mould fabrication machinery: turning, milling, copy milling, pantograph, die sinking, grinding, hobbing.

(8)

MODULE- VII

Mould finishing and polishing, Spark Erosion (EDM), shaping, radial drilling. The Systematic stages in mould making. Prototypes. Handling, cleaning and maintaining moulds and dies.

(6)

Text Books:

1. Injection Mold Design, R.G.W. Pye, George Godwin.
2. Mold Engineering, Herbert Rees, Hanser, 1995
3. How to make Injection molds, Menges/Mohren, Hanser, 1993
4. Plastic Mold Engineering Handbook, Dubois & Rribble, Chapman & Hal, 1987
5. Production Technology, R.K. Jain, S. Chand & Co., 1991
6. Production Technology I & II, Hazra & Choudhary.
7. Blow Molding Handbook, D.V. Rossato, Hanser, 1989
8. Extrusion Dies for Plastics an Rubber, W. Michaeli, Hanser, 1992

PL 6105	ELASTOMER TECHNOLOGY	1.0

MODULE- I

History and growth of rubber technology, general consideration of diene polymers. Natural and synthetic (rubber) Lattices, composition, stability, gelation, preparation of dry rubber from natural rubber latex, types and grades of rubber. Physics of raw vulcanised rubber – Entangled rubber elasticity, Linear viscoelasticity of rubber

(6)

MODULE- II

Natural rubber: Chemical structure, auto oxidation and other reactions, blending with other polymers, compounding, vulcanisation.

(5)

MODULE- III

Chemistry and technology of synthetic rubbers -poly isoprene, SBR, nitrile, polybutadiene, polychloroprene, EVA, EPDM, Butyl rubber, poly sulfide rubbers, chlorosulfonated, silicones, thermoplastic elastomers.

(10)

MODULE- IV

Rubber compounding and Vulcanization principle and mechanism, Mastication, mixing and compounding. Additives - fillers, accelerators, activators, antioxidants, antiozonants, sulfur etc. Theory and technology of reinforcement.

(6)

MODULE- V

Use of textiles as reinforcing materials. Mechanism and practice of sulfur vulcanization and nonsulfur, vulcanization (peroxide, metaloxides and other special curing systems).

(6)

MODULE- VI

Machineries: Mills, Mixers, Extruders, Calendars etc.

(5)

MODULE- VII

Manufacturing of Dipped goods from latex, latex foam, Latex thread, latex treated coir. Rubber coated fabrics, Rubber footwear technology. Using textile, leather, PVC. Extruded rubber profile. Hose technology, conveyor & V- Belt., Rubber coveredrolls, metal rubber bonding. Thermoplastic Elastomer & its potential application, reverse engineering in rubber industries. Technology & manufacture of automic rubber compounds, rubber cables, synthetic Elastomer in industrial application. Type technology : Compounding & processing technology

(7)

Text Books:

1. Rubber Technology and Manufacture: Blow C.M. 2nd Edn. Numbers Butterworth London. 1982
2. Dr. Werner Hoffmann. Rubber Technology Handbook, Hanser Publication, NY, 1996
3. Rubber Technology, Morton,M., N.Y. Vannostrand Reinhold Company, 1973. 2nd Ed
4. Polymer Physics, Rubinstein,M,Colby R.H. Oxford University press , 2003

PL 6107	POLYMER RHEOLOGY	1.0

MODULE- I

Review of equation of continuity and equation of motion

(4)

MODULE- II

Nature of materials pseudoplastics, dilatants, Bingham plastic, Rheopexy and thixotropy. Rheology of Polymer melts.Shear flow. Viscosity models. Dependence of viscosity on Temperature, Pressure, molecular weight etc. Viscous dissipation.

(10)

MODULE- III

Flow through circular, annulus and slit cross section.Techniques of measurement of shear in Capillary viscometer, rotational viscometers, Torque Rheometer. Measurement of die swell. Extensional flow and measurement of extensional viscosity. Measurement of normal stress.

(10)

MODULE- IV

Visco elasticity of Polymers. Linear Viscoelastic models, Model to molecule analogy, Boltzmann stress superposition Principles. Relaxation Spectrum

(5)

MODULE- V

Dynamic Response. Experimental Techniques to determine Transition and Relaxation in Amorphous Polymers. Time Temperature Superposition.

(5)

MODULE- VI

Theories of viscosity of dilute and concentrated solutions. Rheology of suspensions. Rheology of Polymer blends.

(6)

MODULE- VII

Rheological aspects for selection of materials for main techniques of Polymer Processing such as injection moulding, Extrusion, blow moulding, and thermoforming

(5)

Text Books:

1. Middleman, S., The flow of high Polymers, Interscience Publishers.
2. White, J.L., Principles of Polymer Engineering Rheology, John Wiley & Sons, 1990
3. Crawford, R.J., Plastics Engineering, Pergamon Press.
4. Mc Crum, Principles of Polymer Engineering.
5. Brydson J A., Flow Properties of Polymer Melts, George Godnin Ltd.

PL 6111 POLYMER CHARACTERIZATION AND TESTING 1.0

MODULE- I

Mechanical properties of polymers: Principle tests for mechanical properties (tension, shear, compression, flexural, hardness, impact, abrasion, creep, stress relaxation),

(6)

MODULE- II

Electrical properties (receptivity, dielectric strength, permitivity, power factor etc), optical properties (gloss, clarity), Chemical properties (solubility, flammability, LOI, vicat softening point & HDT, permeability, ageing & weathering, ESC, adhesion) flow properties (MFI, viscosity). Determination of Magnetic, Optical (Birefringence & photoelasticity), Nonlinear Optical properties and Acoustic Properties

(7)

MODULE- III

Microscopy- Light microscopy- optical system of microscope, application in polymer characterization-RI, Birefringence, morphology, crystallization (hot stage). Electron microscopy - TEM SEM, Principle, Instrument, Specimen preparations, applications. Application of Scanning transmission Electron Microscopy, X-Ray micro analysis, Analytical electron microscopy(aem), X-ray energy spectroscopy(XES). Electron Scanning chemical analysis (ESCA).

(7)

MODULE- IV

Applications of FTIR, UV-Visible, mass spectrometry, Raman Spectroscopy for polymeric compounds. Nuclear Magnetic Resonance Spectroscopy: The NMR phenomena, Instrumentation, Spin-lattice relaxation, Chemical shift, intermolecular spin-spin coupling, Dipolar line broadening. Broad line spectra, Magic angle spinning (MAS), spin-spin interaction. Analysis of spectra - structural investigation (stereoregularity, chain branching, etc.), Crystallinity. Electron spin resonance spectroscopy

(7)

MODULE- V

X-ray Diffraction Methods: Classification of Crystal systems, Symmetry elements, point Group and Space Group, Principle of X Ray Scattering and Diffraction, Interplaner Spacing Bragg's Law and Laue Conditions. Instrumentation, Application of WAXS and SAXS in polymer characterization- degree of Crystallinity (Ruland's method), Crystallite size analysis, Orientation (Pole Figures), residual stress. X-ray fluorescence Spectroscopy, Application for determination of crystallinity, and residual stresses.

(7)

MODULE- VI

Thermal analysis: Principle, Instrument and application, Differential Scanning Calorimetry(DSC), Differential thermal analysis(DTA), Thermogravimetric analysis (TGA), Dynamic mechanical thermal analysis (DMTA).

(6)

MODULE- VII

Chromatography: Principles and Applications of High Performance Liquid Chromatograpy and High Performance Thin Layer Chromatography, Pyrolysis Gas Chromatography

(5)

Text Books:

1. G. Bodor, "Structural investigation of polymers", ELLIS HORWOOD, 1991
2. T. A. Ossald and G. Menges, "Materials Science of Polymers for Engineers", Carl Hanser Verlag Publishers, 1996
3. Vishu Shah. Hand Book of Plastic Testing Technology, SPE, 1998

PL 6109	POLYMER TECHNOLOGY- II	1.0

MODULE- I

Properties, processing, application and manufacturing process, major engineering problems, economics and Indian scenario of the following: Engineering plastics: Polyamides: nylon 66, nylon 6, nylon 11, nylon 12, polyimides.

(6)

MODULE- II

High performance thermoplastics: Polyacetal, Polycarbonate, Polysulfone, PPO, Polyesters (USP,fibre forming,film-forming).

(7)

MODULE- III

Heat resistance thermoplastics: Polyether sulfone, PPS, Polyether Ketones.

(7)

MODULE- IV

Functional polymers: Photo responsive polymers, Ion conducting polymers, bio polymers (proteins, nucleic acids, polysachharides), Piezoelectric polymers, Inorganic polymers

(5)

MODULE- V

Water soluble polymers, biodegradable polymers, liquid crystal polymers, Magnetic polymers,Polymeric catalysts.

(7)

MODULE- VI

Home application, film packaging application

(5)

MODULE- VII

Plastics in automobile industries, biomedical application, electronic application, cable application, plastics in agriculture application, space and defence application, polymer in building construction, photographic application.

(8)

Text Books:

1. Plastic Materials: Brydson J.A. 3rd Edn. Butterworth Woburn, 1975
2. The Roll of Additives in Plastics, Mascia,L., Edward Arnold, 1974
3. Functional Monomers and polymers Kiichi Jakenioto, Raphael M, Ottenbrites, Mikhiaru kamachi - Marcel Dekker.

SEVENTH SEMESTER

PL 7101	COMPUTER AIDED POLYMER PROCESSING	1.0

MODULE- I

Basic Concepts of CAE, Computerized numerical control: Basic ideas, NC-coordinate systems, absolute and incremental positioning, absolute and floating zero points, G and M codes, APT language Programming.

(6)

MODULE- II

Flexible manufacturing systems: Basic Concepts, elements building blocks, economic aspects of FMS/CIM. Applications of Robotics, Factory of future, Manufacturing cell. CAE in Rapid prototyping

(6)

MODULE- III

Principles of molecular modeling. Group contribution methods for prediction of polymer properties. Softwares for polymer design

(8)

MODULE- IV

Concept of A.I. and Knowledge based systems in selection and processing of polymers.

(5)

MODULE- V

Development of programmes for Polymer Science, Polymer Processing and Product design. Optimization techniques

(8)

MODULE- VI

Capabilities of a few commercial packages used for analysis of various polymer processing techniques, Extrusion and die design: POLYFLOW, POLYCAD, SPR, MOTEX, BILAN, PROWEX, MICROPUS.

(5)

MODULE- VII

Application of softwares for product design, mould and die design and manufacture: AUTOCAD, PROENGINEER. ANSYS, MOLDFLOW.

(7)

Text Books:

1. Technology of Computer Aided Design and Manufacturing, S. Kumar & A.K. Jha, Danpatrai & Co., 1998.
2. Tucker III, C.L., Fundamentals of Computer Modeling for Polymer Processing, Hanser, 1989.
3. O'Brien, K.T., Applications of Computer Modeling for Extrusion and other continuous Polymer Processing, Hanser, 1992.
4. Computational Modelling of Polymers, ed. J Bicerano, Marcel Dekker, 1992
5. Van Krevlen D. W. Properties of Polymer, Elsevier, NY, 1997

PL 7105	POLYMER REACTION ENGINEERING	1.0

MODULE- I

Chemical reaction kinetics: basic features, interpretation of kinetic data in batch and flow systems and effect of process variables on rate of reaction.

(6)

MODULE- II

Single ideal reactions: Batch, CSTR and plug flow reactors. Elementary problems in design of reactors

(7)

MODULE- III

Heterogeneous reacting systems. Catalysis, catalytic reactors.

(6)

MODULE- IV

Residence time distribution. Models of non-ideal flow.

(6)

MODULE- V

Kinetic mechanism of Polymerization Reaction. Kinetic analysis and Mathematical Modeling of Polymerization reaction.

(6)

MODULE- VI

Polymerization Techniques, solution, emulsion and suspension polymerization, merits and limitations. Effect of reactor types on MW and MWD of polymers.

(7)

MODULE- VII

Polymerization Reactor design of industrially important polymers, such as polystyrene, PVC, Nylon 6, PET, Polyethylene etc.

(7)

Text Books:

1. Polymerization Process Modeling, N. A. Dotson, R. Galvan, R. L. Laurence and M. Tirrell, VCH Pub., Inc., 1996
2. Reaction Engineering of Step Growth Polymerization, S. K. Gupta and Anil Kumar, Plenum Press, 1987
3. Fundamentals of Polymer Science and Engineering, Anil Kumar and R. P. Gupta, McGraw Hill, 1998
4. Principles of Polymer System, F. Rodriguez, Taylor and Francis, 4th Ed. 1996
5. Control of Polymerization Reactors, F. J. Schork, P. B. Deshpande and K. W. Lefew, Marcel Dekker, 1993
6. Elements of Chemical Reaction Engineering, H. S. Foglar, 3rd Ed., Prentice Hall of India, 2000
7. Chemical Reaction Engineering, O Levenspiel, Wiley, 3rd Ed., 1999

PL 7103	MACROMOLECULAR SCIENCE- III	1.0

MODULE- I

Chain polymerization, Group transfer polymerization, Olefin Metathesis, Insertion reaction Ring opening polymerization

(6)

MODULE- II

Interfacial condensation and phase transfer catalysis, In-situ Polycondensation, Living Polymers: Preparation and applications

(6)

MODULE- III

Special properties of polymer: Magnetism, Conductivity, Non-Linear Optical properties of polymeric materials.

(6)

MODULE- IV

Thermodynamics of polymer melt, Polymer crystallization, thermodynamics of crystallinity. Crystallography. Determination of crystalline and amorphous chain orientation

(7)

MODULE- V

Polymers in Liquid Crystalline State. Glass-Rubber transition theory and applications

(5)

MODULE- VI

Cross-linked polymer (IPN). Rubber elasticity theory and applications

(4)

MODULE- VII

Photochemistry: The Grothus Draper Law, law of photochemical equivalence, quantum yield, decomposition of HI reaction, Photosensitization, fluorescence, phosphorescence. Scattering (X-ray and Neutron)

(11)

Text Books:

1. A Text Book of Physical Chemistry by S. Glasstone
2. Physical Chemistry by P.C. Rakshit.
3. Fundamentals of Polymer by Anil Kumar & Rakesh K. Gupta, Mc Graw-Hill Inc.
4. Inorganic Chemistry: Cotton and Wilkinson
5. Polymer Physics by L.H. Sperlings.

PL 7105	DESIGN OF PLASTICS PROCESSING MACHINERY	1.0

MODULE- I

Design methodology, factor of safety, codes and standards, reliability, safety and product liability. Concept of Design stress: Static and fatigue strengths, selection of metallic and non-metallic materials, design stress evaluation considering property, size, reliability and stress concentration.

Thin and Thick Cylinders: Radial and circumferential stresses, stresses produced due to shrink fit.

Springs: Open coiled helical spring, leaf spring and spiral spring.

(6)

MODULE- II

Design of power screws, fasteners, and connection: riveted, welded and bonded joints.

(5)

MODULE- III

Basic design and selection principles of power transmission elements such as shafts, and gears

(5)

MODULE- IV

Selection principal of other power transmission elements such as coupling, belts, chains and sprocket.

(6)

MODULE- V

Design of sliding contact and rolling contact bearings.

(5)

MODULE- VI

Design of Injection moulding machinery components: Steel pipe tubing, valves, hydraulic jack, toggle and hydraulic clamps, seals and packings, accumulator and compressor, moulding press pump.

(12)

MODULE- VII

Design of Extrusion machinery components: Extruder screws, disk extruders, ram extruders and barrel.

(6)

Text Books:

1. Mechanical Engineering Design by J.E. Shigley and L.D. Mitchell.
2. Machine Design by A.D. Deutschman et al.
3. Injection Moulding by Irvin I. Rubin.
4. Polymer Extrusion by Chris Rauwendaal.
5. Designing Plastic Parts Assembly by Paul A Tres.

MODULE- I

Fundamental types of surface coating: Lacquer, paint, varnish, and enamel. Lacquer: Constituents - (resins, plasticizer, solvent and diluent), oleo resinous varnishes: Constituents - (drying oil, solvent, drier, pigment - thinners) mechanism of drying, formulation.

(5)

MODULE- II

Paints: Constituents- (resin, binder, solvent, pigment etc.) formulation, varnish, type, lacquer type, polymer emulsion paints, enamel paints, stoving enamel

(5)

MODULE- III

Pigments: role and significance of (a) Interactions between pigments and vehicle (b) wetting and dispersion of pigment particles, effects of pigments on flow properties and hiding power.

Additives in paints: wetting and dispersing agent, anti settling and anti sagging agent, antiskinning agent, anti flooding and fungicidal agent.

(6)

MODULE- IV

Coating Processes: extrusion, roller coating, blade, kiss, dip coating, flow coating, curtain coating, spray painting, electro deposition, chemiphoretic deposition. New technologies - water borne coating, curable coating, powder coating, high solid liquid coating. Industrial coating- (appliance finishes, automotive finishes, coil coatings, can coatings, marine coatings, aircraft finishes, building coatings, paper coatings).

(8)

MODULE- V

Paint properties and their evaluation: Surface treatment of polymers. (mechanism of film formation, factors affecting coating properties, barrier properties of coatings, mechanical, optical, ageing, rheological, adhesion, floating, flooding, silking properties - surface defects.)

(6)

MODULE- VI

Theories of adhesion: mechanical interlocking, electrostatic attraction, diffusion, adsorption, chemisorptions. Properties significant for adhesives and their tests: Cohesive strength, surface tack, peel strength.

(6)

MODULE- VII

Adhesives based on- starch, dextrin, cellulose ester, cellulose ether, natural gum resins, acrylic resins, epoxy resins, phenolics, neoprene rubber adhesives, polyvinyl alcohol,

polyvinyl acetate.

(5)

Adhesive papers, general tapes, pressure sensitive adhesive.

(2)

Printing inks, formulation, methods of printing

(2)

Text Books:

1. Surface Coating Science & Technology - edited by Swaraj Paul, John Wiley & Sons.
2. Handbook of Adhesives - Skeist, Irving, Van Nostrand, New York, 1990. 3rd Ed.
3. Introduction to Paint Chemistry, Bentley & Turner.

Accounting of Business Transactions
Accounting principles, journal and ledger entries, balance sheet, profit and loss statement, ratio analysis

Cost and Cost Analysis
Cost structure, methods of allocating overhead costs, standard cost, concept of opportunity cost, sunk cost, fixed cost and variable cost

Break Even Analysis
Drawing of brake even charts, effect of different variable on break even point, cost comparison of two or three alternatives

Time Value of Money
Single sum and series of cash flow, uniform and gradient series, multiple compounding periods in a year, continuous compounding, bonds

Comparison of Alternative Proposals
Bases of comparison- present worth amount, annual equivalent amount, future worth amount, rate return, defining mutually exclusive alternatives, decision criteria for selection of investment proposals, comparison of alternatives, with unequal service life, sensitivity analysis

Replacement Analysis
Reasons for replacement, evaluation of replacement involving excessive maintenance cost, decline in efficiency inadequacy and obsolescence

Depreciation and Decision Making Under Uncertainty
Methods of depreciation and their comparison, decision making on the basis of expected value decision tree in the evaluation of alternatives

Text Books:
1. Modern Accountancy I.M. Pandey
2. Engineering Economy E.P.Degarmo

EIGHTH SEMESTER

PL 8101	POLYMER BLENDS & COMPOSITES	1.0

MODULE- I

Polymer Blends: Definition, difference between polymer blends and alloys, classification of polymer blends and alloys, principle of polymer compatibility, miscibility effect of molecular structure on polymer-polymer interaction, thermodynamics of polymer-polymer mixing, Blend morphology & characterization.

(9)

MODULE- II

Preparation of PBA: Latex, Solution, Melt, Mechanochemical.
Chemical reactions of polymers in blends, properties, compatibilization.

(5)

MODULE- III

Commercial blends and applications: toughened polymers, PBA in LCP, PBA in fiber composite, PBA in adhesions, high performance engineering PBA.

(5)

MODULE- IV

IPN in polymer blends and alloys.
Polymer concrete: fabrication, properties, applications

(3)

MODULE- V

Polymer composite systems: Types of composites, reinforced thermoplastic, thermoset, elastomer - resins (polyesters, epoxide, vinyl ester, phenol formaldehyde, polyimide, semicrystalline and amorphous polymers - PEEK, PP, PEK, PBT, PC, ABC, nylon etc.) additives, reinforcements (particulate, fibrous, gaseous).

(7)

MODULE- VI

Processing techniques: open mould, hand lay up spray up, vacuum bag moulding, pressure bag moulding, autoclave moulding, closed mould, SMC, DMC, RTM. Continuous manufacturing process- pultrusion, filament winding, centrifugal casting. Application (sandwich constructions- aircraft, racing cars, helicopter rotor blades etc.)

(8)

MODULE- VII

Mechanical behaviour of composites: Analysis of continuous fibre composites, and short fibre composites. Deformation behaviour of single ply and laminates. Creep, Fatigue Impact. Electrical and thermal properties.

(8)

Text Books:

1. Paul D.A., and Newman S., "Polymer Blends", Academic press.
2. Dyson, R.W., "Engineering Polymers", Blackie, 1990.
3. Crawford, R.J., Plastics Engineering, Pergamon Press.
4. Richardson, T., Composites– a design guide industrial press Inc., New York, 1987.

PL 8103	INDUSTRIAL CHEMICAL PROCESSING	1.0

MODULE- I

Fuels: Solid, Liquid and Gaseous. Power Generation. Nuclear power plant. Alternate energy source. Coal chemicals

(7)

MODULE- II

Petroleum processing: Resources and raw material, Exploration; production, Indian Scenario, Constituents. Unit operations and unit processes in petroleum refining, products of refining.

Petrochemical: Historical, research, economics and uses, feed stocks. Pyrolysis and Cracking, Reforming, Polymerization, Alkylation, Hydrodealkylation, isomerization, Hydrogenation, hydroformylation in Petrochemical manufacture

(8)

MODULE- III

Monomer Production for polymers: Ethylene, propylene, styrene, butadiene, vinyl chloride, tetrafluroethylene, vinyl acid esters (MMA, vinyl acetate), acrylonitrile, caprolactum, adipic acid, maleic anhydride, phthalic anhydride, phenol, urea, melamine formaldehyde, bisphenol A, cellulose acetate, monoethylene glycol, terephthalic acid.

(8)

MODULE- IV

Brief outline of the following industries: Ceramic, Glass, Cement, Dye, Wood derived chemicals, Pulp and paper.

(6)

MODULE- V

Brief outline of the following industries: Oils, fats and waxes, Soap and detergent

(5)

MODULE- VI

Hazards, Safety measures and loss prevention in chemical process industry, with special reference to Polymer Industries

(5)

MODULE- VII

Recycling and recovery of Polymers: Mechanical Recycling, Feedstock Recycling, Incineration.

(6)

Text Books:

1. George T.A.,"Shreve's Chemical Process Industries", Mc Graw Hill. 1985
2. Outline of Chemical Technology: Dryden, 2nd Ed., 2001
3. Sinnott, R.K., Coulson and Richardson's Chemical Engineering- 6th Volume, Chemical Engg Design, 2nd Ed., Asian Book Pvt. Ltd.1996

PL 8105	PROCESS CONTROL AND INSTRUMENTATION	1.0

MODULE- I

Process control Instrumentation - Measuring elements (Temperature, Pressure, thickness, power, rotational speed, flow rate, liquid level etc.). Control valves and their characteristics.

(5)

MODULE- II

Concept of feed back and feed forward control system.

Final control element. The controller, Proportional, PI, PID controller, construction of pneumatic and hydraulic controller. Servomotor technology in control.

(6)

MODULE- III

Control system dynamics: Transfer function of first order, second order systems. Response of control loop components to forcing functions. Transfer function of feed back control systems. Control system design. Tests for unstable systems

(7)

MODULE- IV

Conventional control system and hardware.

Advanced control systems: Multivariable control problem, Ratio control, Cascade control, Computed variable control, Feed forward control, Over ride control, Adaptive control etc, Sensors, LVDT, Strain gauge.

(7)

MODULE- V

Data processing for process plants, monitoring and data logging equipment for process control, process control computer equipment. Control based on computed functions. Methods of optimizing control and criteria for optimization, optimizing by computer control.

(6)

MODULE- VI

Application of computer control, on line computer control, predetermined programme control, repetitive computer control, adaptive control, optimizing control of continuous process with significant dynamics. Brief idea about application of Dynamic Matrix Control, Predictive Control, PLC, Fuzzy logic control.

(7)

MODULE- VII

Basic concepts of Control of Polymerization Reactors, Unit operation equipments, Injection moulding machines, Hydraulic presses, Extruders, blow moulding machine etc.

(7)

Text Books:

1. Stephenopolos, S., "Chemical process control", Prentice Hall of India, New Delhi, 1984
2. Luyben, W.L., "Process modelling, simulation, and control for Chemical Engineers", McGrawHill, 1989
3. Considine, D.M., "Process/Industrial Instruments and Controls Handbook", McGraw Hill, 1993
4. Oggunaika B.A. and Ray W.H., "Process Dynamics, Modeling and control". Oxford University Press, U.K. 1994
5. Alciatore D.G. and Histand M.B., “Introduction to Mechatronics”, Tata McGraw Hill
6. Bolton W. “Mechatronics”, Pearson Education (Singapore)

PL 8109	FIBRE SCIENCE AND TECHNOLOGY	1.0

MODULE- I

Natural fibre: Cotton, linen, jute, hemp, sisal, coir, wool, silk, asbestos etc, chemical structures, source, use and limitations. Quest for synthetic fibres.

(10)

MODULE- II

Conventional man made fibres: Rayon, Polyethylene terephthalate , Nylon 6 and nylon 66, Acrylic fibres, Polyolefin's, Polyvinyl Chloride, Polyvinyl Alcohol, Elastomeric.

(3)

MODULE- III

Fibres for high performance, industrial and non-conventional applications: Polymeric- Aramid-Nomex and Kevlar, Ordered polymeric fibre, Aromatic polyesters, PEK, PEEK, Misscellaneous fibres. Carbon fibre. Glass fibre, Boron fibre. Ceramic fibre. Alumina fibre. Metallic fibre. Conducting polymeric fibre. Optical fibre.

(8)

MODULE- IV

Fibre formation and Processing-Principles, machineries, influence of process parameters on structure and morphology of fibre: Spinning, Tow process, Post spinning operations, spin finish, Drawing, Heat setting, Spunbonding and melt-blowing processes. Brief idea about Auxiliary plants and Equipment. Reccycling of fibre waste.

(10)

MODULE- V

Characterization of fibres: Fibre Morphology, Dye uptake, Thermal properties, Chemical stability, Fineness-Denier & Tex, crimping properties, length, twists and intermingling.

(8)

MODULE- VI

Mechanical Properties, Electrical properties, Shrinkage, uniformity, Frictional properties, Tactile and optical properties

(3)

MODULE- VII

Brief outline of manufacture of textiles: Fibres to yarn, Yarns to Fabrics- weaving, knitting, braiding, Compound fabric constructions, Finishing processes, Dyeing and printing.

(3)

Text Books:

1. Gupta, V.B. and Kothari, V.K. Manufactured Fibre Technology, Chapman & Hall, 1997
2. Fourne,Franz, "Synthetic Fibres, Machines, and Equipment, Manufacture, Properties", Hanser Publishes, 1999
3. Corbman, Bernard P, "TEXTILES fibre to fabric", Sixth Edition, McGraw Hill, 1983

ELECTIVE

PL 8111	BIOMEDICAL APPLICATIONS OF POLYMERS	1.0

MODULE- I

Biomaterials: Definition classification, Applications. Biological material and Biomaterials. Implant and transplant. Advantages and disadvantages of various biomaterials. Comparison with natural tissue replacement materials.

(5)

MODULE- II

Structure: property relationship of polymeric (Natural-protein, polysaccharides etc and synthetic-polyolefins, Acrylics, celluloses epoxy, resins, Fluoro polymers, Vinyl polymers, polyurethanes, silicones, hydrogels etc.), and non-polymeric (Metals, ceramics, and composites) Biomaterials. Structure property relationship of mineralized and non mineralized tissues (bone, teeth, skin, ligament, tendon, cartilage etc.) biomaterials

(10)

MODULE- III

Bio compatibility and blood compatibility. Invitro and invivo test for biocompatibility and blood compatibility. Modification to enhance biocompatibility - Copolymerization, blending, surface treatments (Coating, heparinization, grafting etc), thromboresistant surface

(6)

MODULE- IV

Bioactive, Bioresorbable, Biodegradable, Superabsorbent, Biostable and porous tissue ingrowth implant materials. Sterilization of implants. Deterioration of polymer properties.

(4)

MODULE- V

Surgical, medical and paramedical application of polymers

Soft tissue replacement - Extra corporeal, intracorporeal, blood interfacing, sutures, surgical tapes, adhesives, percutanious devices, heart assist device, artificial skin, maxillofacial organs, kidney, eye, etc.

(8)

MODULE- VI

Hard tissue replacement: various joints, fracture fixation devices, dental implants. Bone implant fixation problems and steps to mitigate them

(6)

MODULE- VII

Drug delivery system.
Disposable in Health care.
Packaging.
Polymeric medication.

(6)

Text Book:

1. Biomaterials - An introduction - J.B. Park, Plenum Press.
2. Plastics Materials – J.S. Brydson, 3rd Edn. Buthreoortle, 1975

ELECTIVE

PL 8113	RECYCLING AND RECOVERY OF POLYMERS	1.0

MODULE- I

Waste statistics. Legislation, and economics of plastics recycling. Waste management. Landfilling.

(4)

Few case studies on life cycle analysis: Household plastics waste packaging (PE, PP, PVC), Pet bottles, tyres.

(4)

MODULE- II

Pretreatment of Polymer Wastes: Classification, washing, drying, Size reduction, special cleaning techniques, sorting techniques.

(5)

MODULE- III

Mechanical Recycling: Filtration system, Additives, blend technology in recycling, Problems encountered in extrusion, extrusion blow moulding, injection moulding in recyclates. Press processing of homogeneous recyclates.

(6)

MODULE- IV

Commercial recycling plants. Machineries for plastics recycling.

(2)

Properties and application of Recyclated PE, PP, PS, EPS, PVC, PET, Polyamides, Polyurethanes, FRP, Commingled plastics waste.

(6)

MODULE- V

Feedstock recycling: Degradative Extrusion, Pyrolytic techniques, Hydrogenation, Gasification, Reduction in Blast Furnace, Depolymerization of polyamides, PMMA, Solvolytical process for PET, Polyamides, Polyoxymethylene.

(5)

Energy recovery from Plastic Waste in Waste incineration plant.

(3)

MODULE- VI

Waste Rubber Recycling.

(4)

MODULE- VII

Pollution control in Petroleum Refining and Petrochemical Industries.

(6)

Text Books:

1. Bandrup, Dr.J Ed., "Recycling and Recovery of Plastics", Carl Hanser Verlag, 1995

ELECTIVE

PL 8119	DESIGN OF PLASTICS PRODUCTS	1.0

MODULE- I

Plastic part design process

(2)

Material Selection: Comparative properties of thermodynamics and Thermo set materials. Design related plastics material properties. Test standards.

(4)

MODULE- II

Process Selection Criteria: Injection Moulding, Extrusion, Calendaring, Thermoforming, Blow Moulding, Compression and Transfer moulding, Casting, Filament, Pultrusion etc.

(6)

MODULE- III

Structural Design: Part Geometry, Stress concentration, Support, loading conditions

(4)

MODULE- IV

Beams, plates, shells/ pressure vessels, Torsion, columns, dynamic loads

(4)

MODULE- V

Rapid prototyping: stereo lithography, laser sintering, automated filament extrusion prototyping, laminated object manufacturing, prototype part casting, prototype injection mould tooling, structural foam prototypes. Co-ordinate measuring . Experimental stress analysis.

(8)

MODULE- VI

Assembly of injection moulded parts: Design aspect of press fit, snap joint, mechanical fastening welded joint, adhesive joint.

(10)

MODULE- VII

Case History: compact discs, tie cables, stack of shelves, park bench, bearing, gear, pipe and tubes, shaft pulley, living hinge, connector and bracket using living hinge, joint cap, injection blow moulded bottle etc.

(7)

Text Books:

1. Robert A.Malloy, “Plastic part design for Injection Moulding”, Hanser Publishers, Munich Vienna New York, 1994
2. Paul A. Tres, “Designing Plastic Parts for Assembly”, 2nd, Revised Edition, Hanser Publishers, Munich Vienna New York, 1994
3. N.G. Mc Crum, C.P. Buckley and C.B. Bucknall, Principles of Polymer Engineering, Oxford Science Publications, New York, 1997
4. Belofsky, H., “Plastics Product Design and Process Engineering, Hanser Publishers, Munich Vienna New York, 1994.

ELECTIVE

PL 8121	BASICS IN NANOTECHNOLOGY	1.0

MODULE- I

Nanotechnology and definition, classification of nanomaterials. Top-down versus bottom up approach in manufacturing.

(3)

MODULE- II

Novel physics and chemistry of nanodimensions. Unique chemical, electronic, magnetic, optical, thermal and mechanical properties. Metals, ceramics & semiconductors.

(8)

MODULE- III

Dendrimers– synthesis, properties & structure
Fullerenes– synthesis, properties & structure
Carbon Nanotube- synthesis, properties & structure

(6)

MODULE- IV

Conducting polymers: synthesis & properties of Polyacetylenes, Polyanilines, polyphenylene, polythiophene & polypyrrole
Charge transfer polymers
Ionically conducting polymers
Conductively filled polymers

(10)

MODULE- V

Polymer dopant interaction. Diffusion of dopants, chemistry of doping. Doping level. Marphology of pristine polymers, doped polymers. Mechanism of conduction, Applications

(6)

MODULE- VI

Stimuli responsive Polymers: Solvent, Temperature, pH responsive, Ions, Electrical energy, Photons– Applications.

(6)

MODULE- VII

Principles of molecular self assembly and self organization, surfactant solutions, polymers. Self assembled monolayers, thiol and silane monolayers, Langmnir – Blodgett films, Topological substrate Patterning.

(6)

Polymer surfaces and interfaces, structure and properties.

Text Books:

1. Nanotechnology, T. Pradeep