BTECH DEGREE COURSE IN
POLYMER SCIENCE AND ENGINEERING

SEMESTER I

Sl. No.	Course Code	Subject	L	T	P	Credits	Marks		
							Internal	External	Total
1	PE 1101	Engineering Mathematics I	3	1	0	3	50	50	100
2	PE 1102	Engineering Physics	3	1	0	3	50	50	100
3	PE 1102	Engineering Chemistry	3	1	0	3	50	50	100
4	PE 1104	Engineering Graphics	2	3	0	4	50	50	100
5	PE 1105	Basic Electrical Engineering and Electronics	3	1	0	3	50	50	100
6	PE 1106	Technical Communication	2	1	0	2	50	50	100
7	PE 1107	Mechanical Workshop	0	0	3	2	100	-	100
8	PE 1108	Basic Electrical and Electronics Lab	0	0	3	2	100	-	100
		Total	**16**	**8**	**6**	**22**	**500**	**300**	**800**

SEMESTER II

1	PE 1201	Engineering Mathematics II	3	1	0	3	50	50	100
2	PE 1202	Engineering Mechanics	4	1	0	4	50	50	100
3	PE 1203	Ecology and Environment	2	1	0	3	50	50	100
4	PE 1204	Mechanical Engineering	3	1	0	3	50	50	100
5	PE 1205	Introduction to Macromolecular Science and Engineering	3	1	0	3	50	50	100
6	PE 1206	Physical and Inorganic Chemistry	3	1	0	2	50	50	100
7	PE 1207	Computer Programming	0	1	2	2	100	-	100
8	PE 1208	Introduction to Chemical Analysis	0	0	3	2	100	-	100
		Total	**18**	**7**	**5**	**22**	**500**	**300**	**800**

SEMESTER III

Sl. No.	Course Code	Subject	L	T	P	Credits	Marks		
							Internal	External	Total
1	PE 1301	Engineering Mathematics III	3	1	0	3	50	50	100
2	PE 1302	Fluid Mechanics	3	1	0	3	50	50	100
3	PE 1303	Natural Rubber Production and Technology	3	1	0	3	50	50	100
4	PE 1304	Strength of Materials	3	1	0	3	50	50	100
5	PE 1305	Heat and Mass Transfer	3	1	0	3	50	50	100
6	PE 1306	Organic Chemistry	3	1	0	3	50	50	100
7	PE 1307	Industrial Chemical Analysis	0	0	3	2	100	-	100
8	PE 1308	Identification of Polymers	0	0	3	2	100	-	100
		Total	**18**	**6**	**6**	**22**	**500**	**300**	**800**

SEMESTER IV

1	PE 1401	Applied Statistics	3	1	0	3	50	50	100
2	PE 1402	Quality Management Systems and Safety	3	1	0	3	50	50	100
3	PE 1403	Polymer Synthesis and Manufacture	3	1	0	3	50	50	100
4	PE 1404	Science and Engineering of Rubbers	3	1	0	3	50	50	100
5	PE 1405	Thermodynamics and Reaction Engineering	3	1	0	3	50	50	100
6	PE 1406	Plastics Materials	3	1	0	3	50	50	100
7	PE 1407	Polymer Synthesis	0	0	3	2	100	-	100
8	PE 1408	Chemical Engineering Lab	0	0	3	2	100	-	100
		Total	**18**	**6**	**6**	**22**	**500**	**300**	**800**

SEMESTER V

Sl. No.	Course Code	Subject	L	T	P	Credits	Marks		
							Internal	External	Total
1	PE 1501	Plastic Processing	3	1	0	3	50	50	100
2	PE 1502	Polymer Physics	3	1	0	3	50	50	100
3	PE 1503	Polymer Rheology	3	1	0	3	50	50	100
4	PE 1504	Rubber Processing and Products Manufacture	3	1	0	3	50	50	100
5	PE 1505	Fiber Science and Technology	3	1	0	3	50	50	100
6	PE 1506	Adhesives and Surface Coating	3	1	0	3	50	50	100
7	PE 1507	Polymer Characterization and Properties	0	0	3	2	100	-	100
8	PE 1508	Polymer Processing	0	0	2	1	50	-	50
9	PE 1509	Review Seminar	0	0	1	1	50	-	50
		Total	**18**	**6**	**6**	**22**	**500**	**300**	**800**

SEMESTER VI

1	PE 1601	Latex Technology	3	1	0	3	50	50	100
2	PE 1602	Charaterisation and Testing Methods	3	1	0	3	50	50	100
3	PE 1603	Polymer Products Design	3	1	0	3	50	50	100
4	PE 1604	Polymer Composites and Blends	3	1	0	3	50	50	100
5	PE 1605	Polymer for Electrical & Electronics Applications	3	1	0	3	50	50	100
6	PE 1606	Polymer for Packaging	3	1	0	3	50	50	100
7	PE 1607	Minor Project and Seminar	0	0	3	2	100	-	100
8	PE 1608	Latex Technology Practical	0	0	3	2	100	-	100
		Total	**18**	**6**	**6**	**22**	**500**	**300**	**800**

SEMESTER VII

Sl. No.	Course Code	Subject	L	T	P	Credits	Marks		
							Internal	External	Total
1	PE 1701	Polymers and Environment	3	1	0	3	50	50	100
2	PE 1702	Introduction to Mould and Design	3	1	0	3	50	50	100
3	PE 1703	Failure Analysis of Polymers	3	1	0	3	50	50	100
4	PE 1704	Industrial Management	3	1	0	3	50	50	100
5	PE 1705	Tyre Technology	3	1	0	3	50	50	100
6	PE 1706	Elective II	3	1	0	3	50	50	100
7	PE 1707	Polymer Products Testing	0	0	3	2	100	-	100
8	PE 1708	Elective Based Seminar	0	0	3	2	100	-	100
		Total	**18**	**6**	**6**	**22**	**500**	**300**	**800**

SEMESTER VIII

1	PE 1801	Project Work Report and Viva Voce	0	0	15	12	300	200	500
2	PE 1802	Industrial Training	0	0	15	10	200	100	300
		Total	**0**	**0**	**30**	**22**	**500**	**300**	**800**
		Elective							
	PE 1606	A. Polymers for Packaging B. Polymer Process Modeling and Simulation C. Polymers for Biomedical Applications	3	1	0	3	50	50	100
	PE 1706	A. Polymers in Space B. Polymer Nanocomposites C. CAD/CAM in Polymer Processing	3	1	0	3	50	50	100
		Total				**176**			**6400**

SYLLABUS FOR BTECH DEGREE COURSE IN POLYMER SCIENCE AND ENGINEERING

PE 1101 Engineering Mathematics I (2012 Revised)

Unit I:

Ordinary differential equations: First order differential equations-Methods of solution and Simple applications Linear differential equations of higher orders with constant coefficients-Methods of solution of these equations. Cauchy's linear differential equations. Simultaneous linear differential equations- Simple applications of linear differential equations in engineering problems - Electrical Circuits, Mechanical Systems

Unit II:

Infinite series: Comparison test, ratio test, series of positive and negative terms, concept of absolute convergence, alternating series, Leibniz test (No proofs for any of the above tests) Power series: Interval of convergence of power series, Taylor and Maclaurin series of functions.

Leibniz formula for the n^{th} derivative of the product of two functions (No proof), use of Leibniz formula for the determination of coefficients of the power series.

Unit III:

Partial differentiation: Partial differentiation-Concept of partial derivative - Chain rule- Total derivative- Euler's theorem for homogeneous functions, Differentials and their applications in errors and approximations, Jacobians - Maxima minima of functions of two variables (Proof of the result not required)-Simple applications.

Taylors series expansion for a function on two variables-Simple problems

Unit IV:

Integral calculus: Application of definite integrals: Area, Volume, Arc length, Surface area.

Improper Integrals-Beta function-Gamma function.

Text Books:

1. Engineering Mathematics -Vol1:S.S.Sastry, PHI publishers
2. Advanced Engineering Mathematics: Erwin Kreyzig, Wiley Eastern

References:

Mathematical Techniques: Oxford University Press

Engineering Mathematics: T. Veerarajan, TMGH Publishers

Higher Engineering Mathematics: B. S.Grewal, Khanna Publishers

PE 1102 Engineering Physics

Unit I:

Interference of light - Michelson interferometer - Applications-Interference in thin films Antireflection coatings - Interference filters - Fringes produced by air wedge - Testing of flat surfaces- Diffraction of light - Zone plate - Plane diffraction grating - Reflection and transmission gratings - Determination of wavelength of light - Dispersive and resolving powers - Polarization of light - Double refraction - Nicol's prism - Quarter and half wave plates - Elliptically and circularly polarized light - Optical activity - Specific rotation - Half-shade polarimeter - Applications of polarized light.

Unit II:

Lasers and Holography - Properties of laser light - Coherence of light - Principles of laser action - Population inversion - Optical pumping - Metastable states - Conditions for laser action, Types of lasers - Helium-Neon, Ruby and Semiconductor lasers - Applications of lasers Principles of holography - Recording and Reconstruction of holograms - Applications of holography- Fiber optics - Light transmission through optical fiber - Numerical aperture - Multi and single mode fibers - Step index and graded index fibers - Fiber drawing - Fiber optic communication (basic ideas) - Ultrasonics - Generation of ultrasonic waves - Applications of Ultrasound.

Unit III:

Quantum mechanics - Heisenberg's uncertainty principle - Experimental illustrations - Quantum mechanical wave equation - Time independent Schrodinger equation - Physical significance of wave function - Properties of the wave function - Solution of Schrodinger equation - Atomic and nuclear physics - The Vector atom model- Quantization of orbital angular momentum - Electron spin - Magnetic moment of orbital electron – Pauli's exclusion principle - Zeeman effect - Stark effect- Raman effect. Nuclear physics - Nuclear forces - Properties of the nucleus - Nuclear reaction cross section - Artificial radioactivity - Nuclear reactors - Nuclear fusion - Thermonuclear reactions - Controlled thermonuclear reactions.

Unit IV:

X- rays - Production of X-rays and X-ray spectra - Moseley's law - Properties of X-rays - Applications of X-rays - Diffraction of X-rays by crystals - Bragg's law Crystallography - Unit cell - Seven crystal systems - Bravais space lattices - Packing factor Lattice planes and Miller indices - Energy bands in solids - Conductors, semiconductors and insulators - Intrinsic and extrinsic semiconductors - Conductivity of semiconductors - Fermi level - Applications of semiconductors - p-n junctions - solar cells - Hall effect and its applications - Superconductivity - Superconducting transition - The Meissner effect - Type I and Type II superconductors - Isotope effect - High temperature superconductors - Josephson effect - SQUIDS - Applications of superconductors

Text and Reference Books:

1. J. Jacob Philip - A text book of Engineering Physics, Educational Publishers and Distributors 2002
2. A.S. Vasudeva - Modern Engineering Physics, S. Chand & Co.
3. M.R. Sreenivasan - Physics for Engineers - New Age International

PE 1103 Engineering Chemistry

Unit I

Solid state chemistry: Fundamentals, Bonding in solids, Born-Haber cycle, Point defects, Methods to improve reactivity of solids, Free electron theory, Band theory, Fermi level in semiconductors, Molecular field theory of magnetic materials, Conventional and organic superconductors, High temperature superconductors, Liquid crystals, Applications. Solid surface characterisation: Electron spectroscopy for chemical analysis, Chemical shift, BET isotherm, Thermodynamics of adsorption.

Unit II

Electrochemistry: Fundamentals, Electrode potentials, Types of electrodes, Salt bridge, emf measurement. Concentration cells, Acids and bases, Buffer solutions, pH measurements, Polarisation, Overvoltage. Power generation: Secondary cells, Fuel cells, Photovoltaic effect, Solar cells. Corrosion: Different forms of corrosion, Prevention of corrosion.

Chemical Kinetics: reaction rate, rate constant, rate law, reaction order, first order, second order, pseudo-first order reactions, integrated rate laws, half-life of a reaction and its relation to rate constant. Molecularity, simple unimolecular and bimolecular reactions. Arrhenius equation.

Fast reactions - flash photolysis, flow techniques and relaxation methods.

Unit III

Chemical Thermodynamics: Fundamentals, Molecular interpretation of internal energy, enthalpy and entropy, Heat of reaction, Kirchhofs equation, Troutons rule, Entropy changes accompanying different processes, Nernst heat theorem, Third-law. Free energy: Dependence on pressure and temperature, Gibbs-Helmholtz equation, Free energy changes and equilibrium constant, Chemical potential, Fugacity, Thermodynamics of biochemical reactions.

Unit IV

Engineering materials: Industrial polymers-polymerization techniques, structure-property relationships, polymer additives, polymer processing methods (extrusion, injection, compression, transfer and blow molding methods). Nanomaterials: definition, classification and applications.
Nanometals and nanoceramics - examples and properties.
Lubricants: classification, functions and properties. Mechanism of lubrication.
Refractories: classification and properties. Portland cement, lime and plaster of Paris manufacture, setting and hardening.
Chemistry of optical fibres, fullerenes and organoelectronic materials (introduction only).

Text Books

1. Peter Atkins and Julio de Paula, Elements of Physical Chemistry, Oxford University Press, 2005
2. Shashi Chawla, A Text Book of Engineering Chemistry (3rd edn.).; Dhanpat Rai & Co, New Delhi, 2003.
3. Engineering Chemistry (2nd edn) K E George , Rani Joseph, Ushamani M.

References

1. Atkins, P.W., Physical Chemistry, Oxford University Press, UK, 1998
2. Bhatnagar, M. S.,Textbook of Pure & Applied Physical Chemistry, A. H. Wheeler & Co, New Delhi, 1999.
3. Geoffrey Ozin, Andre Arsenault Nanochemistry: A Chemical Approach to Nanomaterials.; Royal Society of Chemistry, U.K., 2005.

PE 1104 Engineering Graphics

Unit I

Introduction to engineering graphics. Drawing instruments and their use. familiarisation with current Indian Standard Code of Practice for general engineering drawing.

Scales- plain scale, vernier scale, diagonal scale.

Conic sections- Construction of ellipse, parabola, hyperbola - construction of cycloid, involute, archimedian spiral and logarithmic spiral- drawing tangents and normals to these curves.

Unit II

Introduction to orthographic projections- plane of projection- principles of first angle and third angle projections, projection of points in different quadrants.

Orthographic projection of straight lines parallel to one plane and inclined to the other plane- straight lines inclined to both the planes- true length and inclination of lines with reference planes- traces of lines.

Projection of plane laminae of geometrical shapes in oblique ositions.

Unit III

Projection of polyhedra and solids of revolution- frustum, projection of solids with axis parallel to one plane and parallel or perpendicular to other plane- projection of solids with axis inclined to both the planes- projection of solids on auxiliary planes.

Section of solids by planes inclined to horizontal or vertical planes- true shape of sections.

Introduction to isometric projection- isometric scales, isometric views- isometric projections of prisms, pyramids, cylinders, cones and spheres

Unit IV

Development of surface of cubes, prisms, cylinders, pyramids and cones

Intersection of surfaces- methods of determining lines of intersection - intersection of prism in prism and cylinder in cylinder.

Introduction to perspective projections : visual ray method and vanishing point method- perspective of circles- perspective views of prisms and pyramids.

References

1. Engineering Graphics
   P. I. Varghese & K. C. John, JET Publishers

2. Elementary engineering drawing
   N. D. Bhat, Charotar publishing house

3. Geometric drawing,
   P. S. Gill, B.D Kataria & Sons Ludhiana

4. Engineering Graphics
   P. I. Varghese, VIP Publishers.

PE 1105 Basic Electrical Engineering and Electronics

(A) Electrical Engineering

Unit I

Basic principles of Electric circuits: Review of Ohms law - Definition of resistance, current, voltage and power - Series and parallel circuits- constant voltage source and constant current source.

Network Theorems: Kirchoffs laws- Network analysis by Maxwell's circulation currents Thevenin's theorem - Superposition theorem - Norton's theorem - Simple illustrative problems on network theorems.

Review of electrostatics - Coulomb's Law- Electric field strength and Electric flux density capacitance.

Unit II

Review of electromagnetic induction -Faraday's Law- Lenz's Law - mutually induced emf.

Magnetic circuits - magnetic field of a coil - Ampere turns calculation - magnetic flux - flux density - field strength.

Measuring instruments: Working principle of galvanometer, ammeter, voltmeter, wattmeter & energy meter.

AC fundamentals: Generation of alternating voltage and current - equations of sinusoidal voltage and current - wave form, cycle frequency, time period, amplitude, phase difference, rms value, average value, power factor & form factor. Vector diagram - addition and subtraction of vectors- sine waves in phase and out of phase. AC circuits: RC, RL, RLC circuits-series and parallel - current, voltage and power relationships. Poly phase circuits: vector representation phase sequence- star and delta connections.

(B) Electronics Engineering

Unit III

Passive components: Resistor - Capacitor - Inductor - Color coding. Transformer- different types, construction.

Semiconductors: Energy band diagram - intrinsic & extrinsic semi conductors, doping - PN junction - Diodes, Zener diodes- Characteristics - Application of diodes. Rectifiers- Half wave, full wave and Bridge rectifiers - Ripple factor and regulation.

Transistors: - PNP and NPN transistors - theory of operation - Transistor configurations characteristics - comparison.

Special semiconductor devices - PET - SCR - LED - LCD - V-I characteristics, applications.

Unit IV

Fundamentals of Instrumentation: Transducers - Definition - Classification - Active & passive - Transducer for position, pressure, velocity, vibration and temperature measurements.

CRO - principle of operation - measurement of amplitude, frequency and phase.

Fundamentals of Communication: Analog communication - concept of modulation, demodulation. Types: AM - FM -PM- Block diagram of general communication system -Basic concepts of digital communication - Block diagram.

Text Book:

1. Basic Electronics - Solid State - B. L. Theraja, S. Chand & Co.
2. Fundamentals of Electrical Engineering - Leonard S. Bobrow, Oxford University Press.

References:

1. Electrical Technology: Edward Hughes, Addison Wesley Publication
2. Electronic Devices & Circuits: G.K. Mithal & Ravi Mittal, Khanna Publishers

PE 1106 Technical Communication

Unit I

Oral Communication: starting and ending a conversation; telling and asking people to do things; expressing opinions and ideas, decisions and intentions, offers and invitations, feelings, right and wrong, numbers and money.

Purpose and audience; dealing with customers and clients; face-to-face discussions; meetings and attending meetings; checking understanding; raising questions; giving and receiving feedback; using body language; leading and directing discussions; concluding discussions; using graphics in oral presentations

Unit II

Reading Comprehension and reference skills: skimming and scanning; factual and inferential comprehension; prediction; guessing meaning of words from context; word reference; comprehending graphics in technical writing.

Reading strategies; reading speed; reading between the lines for hidden meaning; interpreting graphics; using a dictionary; using an index; using a contents list to find information; choosing the right reference source.

Unit III

Written Communication: note making and note taking; summarising; notes and memos; developing notes into text; organisation of ideas: cohesion and coherence; paragraph writing: ordering information in space and time; short essays: description and argument; comparison and contrast; illustration; using graphics in writing: tables and charts; diagrams and flow-charts; maps, plans and graphs.

Unit IV

Spelling rules and tips; writing a rough draft; editing and proof reading; writing the final draft; styling text; filling in complex forms; standard letters; CV; writing a report; writing leaflets and brochures; writing references; essay writing:

expository writing; description of processes and products; classification; the instructional process; arguments and presentation of arguments; narrating events chronologically.

Text Books:

1. Meenakshi Raman and Sangeetha Shanna : Technical Communication:Principles and Practice, Oxford University Press, 2004

References:

1. Adrian Doff & Christopher Jones, Language in Use. Upper intermediate, self-study workbook & classroom book, Cambridge University Press, 2000.
2. Krishna Mohan & Meenakshi Raman, Effective English Communication,Tata Mc-Graw HiII, 2000.
3. Krishna Mohan & Meera Banerji, Developing Communication Skills Mac Millan India Ltd, 2000.
4. Rajendra Pal & JS KoriahaIli, Essentials of business communication, S. Chand & Company Ltd.
5. Sarah F'reeman, Study Strategies, Orient Longman, 1978.

PE 1107 Mechanical Workshop

1) Fitting Shop
2) Sheet Metal Shop
3) Foundry Shop
4) Welding Shop
5) Carpentry Shop
6) Lathe
7) Shaping m/c, planning m/c, milling m/c, Drilling and Boring m/c

(Preliminary exercises for beginners in all shops. Specific models may be designed by the teachers.)

References:

1. Workshop Technology Vol. 12 — Hajra Chowdhary
2. Workshop Technology Vol. 12 — R.S. Khurmi
3. Workshop Technology — Chapman

PE 1108 Basic Electrical and Electronics Lab

1. One lamp controlled by one switch
2. Series and parallel connections of lamps.
3. Stair case wiring.
4. Hospital Wiring.
5. Godown wiring.
6. Fluroscent lamp.
7. Connection of plug socket.
8. Different kinds of joints.
9. Transformer winding.
10. Soldering practice.
11. Familiarisation of CRO.

SEMESTER II

PE 1201 Engineering Mathematics 1I

Unit I

Matrices and Vector spaces: Rank of matrix, Echelon and normal form, Solutions of linear systems of algebraic equations, Eigen values and Eigen vectors, Cayley Hamilton theorem (non proof).

Vector Spaces – Subspaces, - Linear Independence of vectors - Linear span-Dimension and Basis. Linear transformations.

Unit II

Fourier series and Fourier integrals: Fourier series of Periodic functions- Euler formulae for Fourier coefficients- functions having period 2p, arbitrary period-even and odd functions-half range expansions, Fourier integral, Fourier cosine and sine transformations, linearity property, transform of derivatives, convolution theorem (no proof)

Unit III

Laplace transforms: Linearity property, transforms of elementary functions, Laplace transforms of derivatives and integrals, differentiation and integration of transforms, convolution theorem (no proof) use of Laplace transforms in the solution of initial value problems, unit step function, impulse function - transform of step functions, transforms of periodic functions.

Unit IV

Vector calculus: Scalar and Vector point functions-Gradient and directional derivative of a scalar point function- Divergence and Curl of a vector point functions-their physical meanings.

Evaluation of line integral, surface integral and volume integrals, Gauss's divergence theorem, Stoke's theorem (No Proof of these theorem), conservative force fields, scalar potential.

Text Books

1. Advanced Engineering Mathematics: R.K.Jain, S.R.K.Iyengar, Narosa Publishers.
2. Advanced Engineering Mathematics: C.R.Wilie & L.C.Barrett, Mgh

References

1. Mathematical Techniques for Engineers & Scientists, Larry C Andrews, Ronald C Philips, Phi Publishers
2. Advanced Engineering Mathematics, M.C.Potter, J.L.Goldberg Oxford Unversity Press
3. Higher Engineering Mathematics: B.S.Grewal, Khanna Publishers

PE 1202 Engineering Mechanics

A) Statics

Unit I

Concurrent forces in a plane: Principles of statics. Composition and resolution of forces. Equilibrium of concurrent forces in a plane. Method of projection. Method of moments. Friction.

Parallel forces in a plane: Two parallel forces. General case of parallel forces in a plane. Centre of parallel forces and centre of gravity, Pappus theorems, centroids of composite plane figures and curves. Distributed forces in a plane.

Unit II

Properties of areas: Moment of inertia of a plane figure with respect to an axis in its plane. Polar moment of inertia. Product of inertia. Principal axes. Mass moment of inertia of material bodies.

General case of forces in a plane: Composition of forces in a plane.

Equilibrium of forces in a plane. Plane trusses - Method of joints. Method of sections. Plane frames : Method of members. Principle of virtual work: Equilibrium of ideal systems, stable and unstable equilibrium.

B) Dynamics

Unit III

Rectilinear translation: Kinematics of rectilinear motion. Differential equation of rectilinear motion. Motion of a particle acted upon by a constant force, by a force as a function of time and by a force proportional to displacement. Simple harmonic motion. D'Alembert's principle. Momentum and impulse. Work and energy, ideal systems, conservation of energy. Impact.

Unit IV

Curvilinear translation: Kinematics of curvilinear translation. Differential equations of motion. Motion of a projectile. D'Alembert's principle in curvilinear motion. Moment of momentum. Work and energy in curvilinear motion.

Rotation of a rigid body: Kinematics of rotation. Equation of motion of a rigid body rotating about a fixed axis. Rotation under the action of a constant moment. Compound pendulum. General case of moment proportional to the angle of rotation. D'Alemberts principle of rotation. Resultant inertia force in rotation. Principle of angular momentum in rotation. Energy equation for rotating bodies.

References

1. Engineering Mechanics - Timoshenko and Young - McGraw Hill Book Company.
2. Mechanics for Engineers (Vol. 1- Statics and Vol.2 - Dynamics) - Beer F. P. & Johnston E. R. - Tata McGraw Hill.
3. Engineering Mechanics (Vol. 1- Statics and Vol.2 -Dynamics) - Merriam H. L. & Kraige L. G. - John Wiley and Sons.
4 Engineering mechanics- Biju N-Educational Publications –

PE 1203 Ecology and Environment

Unit I

Science, Technology and Ethics

Impact of science and technology on the development of modem civilization. The philosophy of modern science, scientific detenninism - uncertainity principle. Relevance of scientific temper. Science and religion. Science and technology in developing nations. Technological advances of modern India. Intermediate and appropriate technology.

Development of technical education in India.

Unit II

Senses of Engineering Ethics - Variety of moral issues - Types of inquiry - Moral dilemmas - Moral autonomy Kohlberg's theory - Gilligan's theory - Consensus and Controversy - Professional ideals and vinues - Attributes of an ethical personality - Theories about right action - Self interest.

Responsibilities and Rights of engineers - Collegiality and Loyalty - Respect for authority - Collective bargainingConfidentiality - Conflicts of interest - Professional rights.

Unit III

Environmental Studies:

Natural resources - issues related to the use and over exploitation of forest resources, water resources, mineral resources, food resources and energy resources - role of an individual in conservation of natural resources - equitable use of resources for sustainable life styles.

Concept of an ecosystem - structure and function - energy flow in the ecosystem - ecological succession - food chains, food webs and ecological pyramids - structure and functions of a forest ecosystem and an aquatic eco system.

Definition of biodiversity - genetic, species and ecosystem diversity - biogeographical classification of India - Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values.

Unit IV

Causes, effects and control measures of air pollution, water pollution, soil pollution, noise pollution, marine pollution, thermal pollution and nuclear hazards - Causes, effects and control measures of urban and industrial solid wastes -Role of an individual in prevention of pollution - An overview of the various environmental legislations in India - Issues involved in enforcement of environmental legislation.

The concept of sustainable development - Urban problems related to energy - Water conservation, rain water harvesting, water shed management - Resettlement and rehabilitation of people; its problems and concerns - Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust - Population growth and problems of population explosion - Environmental ethics: issues and possible solutions..

Text Books:

1. Rajagopalan. R : Environmental Studies: From Crisis to Cure, Oxford University Press, 2005.
2. Jayashree Suresh and B.S. Raghavan Professional Ethics, S. Chand & Company Ltd., 2005
3. WC Dampier History of Science, Cambridge University Press.

References:

1. Edmund D. Seebaur & Robert L. Barry Fundamentals of Ethics for Scientists and Engineers, Oxford University Press, 2001.
2. Sarah Freeman, Study Strategies, Orient Longman, 1978.
3. Meenambal T, Uma R M and K Murali Principles of Environmental Science and Engineering, S. Chand & Company Ltd, 2005.

PE 1204 Mechanical Engineering

Unit I

Material Science: Classification of Engineering materials - Metals, alloys, ceramics, glasses, polymers-Mechanical, Thermal and Chemical properties of materials.

Fuels: Classification - Solid, Liquid, Gaseous and Nuclear - Calorific values (HCV & LCV) Determination of calorific values.

Pattern making: Types - Materials - allowances

Moulding-Tools-Equipments-Sands-Preparation of sands-desirable properties additives-Cope-drag-check-coves-core prints-gating-reserving.

Unit II

Boilers - Classification of boilers-Sample Vertical, Cochran, Locomotive, Babcox & Wilcox and La-mant boilers - Boiler mountings and accessories- Electric furnaces.

Internal Combustion Engines

Classification - 2 stroke - petrol - diesel - Fuel system, Simple carburetor, diesel- Fuel pump & injector - petrol fuel pump Ignition system- Battery coil & Magnets codling system - Lubrication system.

Unit III

Introduction to machine elements - shafts -fly wheels - bearings - clutches- cone clutches - single plate clutch - shaft couplings.

Mechanical Power Transmission

Belt-rope-chain-gear drives Belt drive - open - closed - velocity rates-slip- length of belt power transmitter-stopped pulling - Gear drive-Types of gears- Types of gear drives-Spur gear nomendations- Velocity ratio.

Unit IV

Welding-Classification-Oxy-acetylene welding -gear welding equipment-arc welding equipment-Arc welding-Resistance welding- Thermal welding -TIG-Safety devices-Introduction to soldering& brazing.

Metal working-hot and cold working, rolling -extrusion-drawing forging- bending-shearing - punching metal cutting -cutting tools-classification, materials, Cutting fluids-Purpose-desirable qualities, Machine Tools: Lathes- Types of Lathes, Engine Lathe-parts-operations, Milling machine- Planning machine- Drilling machine-Shaping machine-Guiding machine-Main parts.

Reference Books

1. Material Science - By J. C. Anderson
2. Material Science - By Raghavan
3. Heat Engine - By P. L. Balleny
4. Mechanical Technology - By R. S. Khurmi
5. Elements of Workshop Technology Vol.I & II - By B. K. Hajra Choudhury, S. K. Bose, A. K. Chowdhury and other available books.

PE 1205 Introduction to Macromolecular Science and Engineering (2012 Revised)

Unit I

Definitions and basic concepts of Polymer Science. History of Macromolecular Science. Molecular forces and Chemical bonding in polymers. Advantage of polymers. Global scenario of polymer industry. Present status of polymer industry in India. Polymers as engineering materials. Comparison of polymers with other materials such as metals, and ceramics. Raw materials for the manufacture of polymers. Classification of Polymers as rubber plastics and fibre.

Unit II

Step-reaction (condensation) polymerization. Mechanisms of condensation polymerization. Kinetics and statistics of condensation polymerization. Molecular- weight control. Prediction of gel point.

Radical chain (addition) polymerization. Mechanism of vinyl polymerization: generation of free radicals, initiation, propagation, termination, chain transfer, inhibition and retardation. Kinetics of radical addition polymerization. Control of molecular weight. Effects of temperature and pressure on chain polymerization.

Unit III

Ionic and coordination chain (addition) polymerization, anionic polymerization. Cationic polymerization, living polymers, coordination polymerization. Mechanism of Ziegler-Natta polymerisation.

Co-polymerization: Mechanisms of co-polymerization. Ionic co-polymerization, step reaction co-polymerization. Block and graft co-polymers.

Unit IV

Comparison of polymerization systems: bulk polymerization, solution polymerization, emulsion polymerization, and suspension polymerization. Type of reactors: batch reactors, tubular flow reactors, stirred tank reactors.

Books

1. Polymer Chemistry – Properties and Applications, Andrew Peacock and Allison Calhoun, Hanser Publishers.
2. Text Book of Polymer Science, F.W. Billmeyer Jr., John Wiley and Sons.
3. A Textbook of Polymers (Volume I), M.S. Bhatnagar, S. Chand and Company.
4. Fundamentals of Polymer science and Engineering, Anil Kumar and S.K. Gupta, Tata McGraw-Hill Publishing Company Limited.

PE 1206 Physical and Inorganic Chemistry

Unit I

General Principles of Metallurgy: Occurrence of metals based on

standard electrode potential, concentration of ores, calcinations, roasting, smelting, role of C and other reducing agents, electrolytic reduction, hydrometallurgy, Ellingham diagrams. Methods of refining and purification-electrolytic, chromatographic, ion exchange, solvent extraction, oxidative refining, zone refining, Kroll process, Van Arkel, Mond process and vacuum process. Extractive metallurgy of Ni, Ti, Zi and U.

Unit II

Co-ordination compounds: Nomenclature-chelates-stereo chemistry of different coordination numbers-isomerism in co-ordination complexes-bonding in transition metal complexes: Valence bond theory, crystal field theory. Effects of crystal field and splitting-Jahn Teller distortion-tetrahedral complexes. Stability of complexes and factors influencing the stability.

Unit III

Organometallic compounds: Definition and classification-nomenclature of organometallic compounds-denticity of ligands-ionic compounds-compounds with transition metals-Pi-type bonding in organometallic compounds- 18 electron rule and structural prediction.

Solutions: Colligative properties – Depression and elevation of physical constants, osmosis, osmotic pressure–expression for osmotic pressure–Van't Hoff equation.

Unit IV

Chemical kinetics: Rate and order of reaction-experimental methods-molecularity- First and second order rate expressions. Rate of temperature-collision theory, rate constant from collision theory. Activated complex theory-Entropy of activation-theory of unimolecular reactions. Catalysis-homogeneous catalysis-enzyme catalysis-surface catalysis and surface reaction.

Determination of molecular mass from colligative properties – isotonic solutions – The ideal solution, Raoults law, Temperature composition and pressure composition diagrams, solubility of gases in liquids, Henry's law.

References:

1. Advanced Inorganic Chemistry, Cotton & Wilkinson, John Wiley East ern Ltd.
2. Concise Inorganic chemistry, J.D.Lee, ELBS, London
3. Modern Approach to Inorganic Chemistry, Bell and Lott
4. University General Chemistry, C.N.R.Rao
5. Co-ordination Chemistry, Basalo and Hohnson
6. Theoretical Inorganic Chemistry Hybey

PE 1207 Computer Programming

Unit I

Introduction to programming in C: Fundamental data types- integer, floating point, and enumerated data types, Expressions - arithmetic, relational and logic operators, Type conversion - simple and compound statement, Access to standard library, standard I/O-getchar, putchar, Formatted I/O, scanf, printf, error handling, line input and out put, control structures, selection statement, IF, SWITCH, WHILE, DO WHILE, FOR, BREAK, CONTINUE, GOTO, RETURN statements.

Unit II

Functions: Declarations and functions, parameter passing mechanism, storage classes-scope, visibility, and life time of variables, AUTO, EXTERN, STATIC and REGISTER modifiers, Recursion.

Unit III

Arrays: Single and multi dimensional arrays, sorting, selection sort, search-linear search and binary search, Structures and union.

Unit IV

Pointers: Pointers and addresses, pointer arrays, function returning pointers, pointers to function, pointer arithmetic, pointers to structures, array of structures, preprocessor directive, command line arguments, typedef.

Text Book & References:

1. Computer Fundamentals & Programming in C :
   Pradip Dey & Manas Ghosh (OXFORD)
2. Computer Fundamentals : Dr. Varghese Paul (EPD)
3. Programming in C : B. S. Gotfried
   (Schaum series, TMH)

Computer programming laboratory

1. Study of as commands. General introduction to application packages.
2. Programming using C. Control structures & pointers.
3. Searching & sorting
4. Creation and use of databases in a suitable database package
5. Programming exercises in C.

PE 1208 Introduction to chemical analysis (lab)

1. Introduction

   1.1 Equivalent weight of compounds

   Principle of volumetric analysis

   Apparatus used in volumetric analysis

2. Acidimetry and Alkalimetry:

   Estimation of Hydrochloric acid, Sulphuric acid, Potassium carbonate, Sodium hydroxide, Hardness of water.

3. Permanganometry:

   Estimation of Oxalic acid, Mohr's salt.

4. Iodimetry and Iodometry:

   Estimation of Iodine, Copper, Potassium dichromate

5. Complexometry:

   Estimation of Magnesium, Zinc.

Reference:

B.Sc. Practical Chemistry – A.O Thomas

SEMESTER III

PE 1301 Engineering Mathematics III

Unit I

Complex Analytic functions and conformal mapping: curves and regions in the complex plane, complex functions, limit, derivative, analytic function, Cauchy – Riemann equations, Elementary complex functions such as powers, exponential function, logarithmic, trigonometric and hyperbolic functions.

Conformal mapping: Linear fractional transformations, mapping by elementary function like Z2, ez, sin z, cosz, sin hz, and Cos hz, Z + 1/Z

Unit II

Complex integration: Line integral, Cauchy's integral theorem, Cauchy's integral formula, Taylor's series, Laurent's series, residue theorem, evaluation of real integrals using integration around unit circle, around the semi circle, integrating contours having poles, on the real axis.

Unit III

Partial differential equations:

Formulation of partial differential equations.

Solutions of equations of the form F (p,q) = 0, F(x,p,q) = 0, F(y,p,q) = 0, F(z,p,q) = 0, F1(x,p) = F2 (y,q), Lagrange's form Pp+Qq = R

Linear homogeneous partial differential equations with constant coefficient

Unit IV

Vibrating string: one dimensional wave equation, D'Alembert's solution, solution by the method of separation of variables

One dimensional heat equation, solution of the equation by the method of separation of variables,

Solutions of Laplace's equation over a rectangular region and a circular region by the method of separation of variables.

Text Books

Advanced engineering mathematics: R.K.Jain, S.R.K.Iyengar, Narosa Publishers.

Advanced engineering mathematics: C.R.Wilie & L.C.Barrett, Mgh.

References

Advanced Engineering Mathemartics Erwin Kreyszig, Wiley Eastern.

Complex Variables & Applications Churchill R.V.. Mgh Publishers.

Advanced engineering mathematics M.C.Potter, J.L.Goldberg Oxford Unversity Press.

Higher engineering mathematics: B.S.Grewal, Khanna Publishers.

PE 1302 Fluid Mechanics

Unit I

Properties of fluids: Pressure, density, bulk modulus, dynamic and kinematic viscosity, Newton's Law, Surface Tension, Capillarity, Fluids at rest, Pascal's law, Pressure measurement, manometers, pressure gauge, pressure on immersed surfaces, floating body, variation of pressure with elevation.

Unit II

Fluids in motion, Laminar and turbulent flow, Reynold's number, Continuity equation, Hagan Poiseuille equation, Euler's equation in

one dimension, Bernoulli's equation, Discharge measurement, Venturimeter, Orificemeter, Rotameters and Pitot tube, Weirs, Notches.

Fluid friction in pipes, Fanning equation, Losses due to sudden expansion, contraction, fittings and valves.

Unit III

Pumps: Reciprocating positive displacement pumps, Rotary positive displacement pumps, Centrifugal pumps, Flow through packed beds, Cyclone separators.

Unit IV

Drag force on solid particles in fluids, Settling under gravity, Terminal velocity, Filtration, Plate and frame filters, Rotary vaccum filters, fluidization, sedimentation.

Books:

1) Unit Operations of Chemical Engineering Mc Cabe & J C Smith, Mc Graw Hill (1983).
2) Introduction to Chemical Engineering, W L Badger and Banchero, Mc Graw Hill (1955).
3) Chemical Engineering J M Coulson and J M Richardson, Pergamon press (1979) relevant volumes.

PE 1303 Natural Rubber Production Technology

Unit I

Various sources of natural rubber, history and development of Hevea Brasiliensis as the commercial source of natural rubber, present status and future prospects of rubber plantation industry in the world with particular emphasis on Indian context, rubber belt in the world, rubber tree - its propagation planting and maintenance.

Unit II

Latex-physical nature and chemical composition, biosynthetic pathway of natural rubber production, method of tapping and yield

stimulation, pre- coagulation and its prevention. Theories of coacervation, short term and long term preservation.

Unit III

Various marketable forms of natural rubber. Processing of latex into preserved field latex and preserved latex concentrates, different methods used for concentration. Specification for concentrated latex and its grading, packing and despatch. Skim latex, production of skim rubber, its properties and uses. Processing of field latex into ribbed smoked sheets and pale amber coloured sheets, their grading baling and despatch. Manufacture of various types of crepe rubber, grading, baling and despatch.

Unit IV

Processing of the crop into technically specified block forms of rubber, different methods used for block rubber production, their specification, grading, baling and despatch.

Processing of the crop into superior processing and processing aid rubber, constant viscosity and low viscosity rubber, oil extended rubber, tyre rubber, powdered natural rubber, graft, natural rubber rubber master batches.

Books

1. Handbook of Natural Rubber Production in India, Published by RRII, Rubber Board.
2. High Polymer Latices, Volume 1, D.C.Blackly, Applied Science Pub- lishers Ltd., London.
3. BIS specifications.

PE 1304 Strength of Materials

Unit I

Stress and Strain - axially loaded members and loads at the ends and in between ends of uniform section - stepped bars - Composite bars - Hooke's Law - Stress - Strain diagram - Linear strain - Lateral strain - Poisson's ratio- elastic constants - Relation between 3 elastic constants - Thermal strain energy- simple problems

Unit II

Graphical: Compound stress - stresses on inclined planes - Principal planes - Principal stresses - Mahr's circle. Design of riveted joints - Checking for shearing of plane - Shearing of rivet-Crushing of rivet.

Unit III

Shear force & Bending Moment, SF & BM diagram - Cantilever - Simply supported beams - over hanging beams - Transverse and inclined loads - Point loads - Uniformly distributed loads - triangular loads. Relation between SF & BM - Simple problems.

Unit IV

Thin cylinders under internal pressure - stresses - changes in dimensions and volume - simple problems. Deflection of beams.

Differential equation for deflection, derivation - assumptions - simply supported beams - Point load - Uniformly distributed load - cantilever point load at the end, not at the end - u d load throughout the span and part of the span. (Simple problems).

Reference:

1. S. Ramamrutham- Strength of Materials - Dhanpat Rai Publising Co.
2. R.S. Khurmi - Strength of Materials - S. Chand & Co.
3. R.K. Banzal -A Text Book of Strength of Materials – Laxmi Publications(P) Ltd.
4. Egor P. Popov -Engineering Mechanics of Solids Pearson Education

PE 1305 Heat and Mass Transfer

Unit 1

Modes of heat transfer-conduction- Fouriers law-steady state conduction across a flat wall-compound wall- steady heat flow through

a cylinder-problems-differential equation for unsteady one dimensional flow.

Unit 2

Principles of heat flow in liquids-counter current and cocurrent flows-energy balance in exchangers and condensers-LMTD-individual and overall heat transfer coefficients-forced and natural convection-turbulent and laminar flow-dimensionless numbers and dimensionless equations-corrections for viscosity change and tube length. Evaporators-material and energy balance-single effect calculations-types of evaporators-multieffect evaporation.

Unit 3

Vapour-liquid equillibria-ideal solutions-Roults and Henrys laws – boiling point diagram from Raoults Law-simple distillation-steam distillation-relative volatility-continuous binary rectification-no. of ideal plates by Mcabe Thiele method-plate efficiency-rectification columns-constructional details

Unit 4

Principles of diffusion-Ficks law-mass transfer coefficients-principles of gas absorption-absorption towers-principles of drying –drying equipment- filtration principles-filtration equipment-drum filter-continuous filtration-gravity settling cyclones

Books:

1) Unit Operations of Chemical Engineering Mc Cabe & J C Smith, Mc Graw Hill (1983)

2) Introduction to Chemical Engineering , W L Badger and IT Banchero, Mc Graw Hill (1955)

3) Chemical Engineering J M Coulson and J M Richardson, Pergamon press, (1979) relevant volumes

PE 1306 Organic Chemistry

Unit I

Covalent bond: Hybridisation and orbital overlap in molecules like ethane, ethylene, acetylene, benzene and cyclohexane. Their geometry.

Stereo isomerism: Optical isometrism in lactic and tartaric acids – Explanation – Elements of symmetry and chirality D.L. Configuration – Fischer and Newman projection formulae. Racemisation, recemic mixture – methods of resolution.

Unit II

Grignard reagent and related compounds: Introduction – Grignard reagent – Alkyl lithium – Synthetic applications.

Ethers: Reactions of epoxides – Claisen rearrangement mechanism, Zeisel's method of estimation of alkoxy groups.

Heterocyclic compounds: Structure, preparation and properties of Furan, Pyrrole, Pyridine, Indole, Pyrimidine and Purine. Reaction mechanism:Polarity of bonds-inductive mesomeric and electromeric effects, resonance, hyper conjugation, steric effects, classification of organic reactions, bond fissions, reaction intermediates, carbocations-their stability and rearrangements- carbanions-free radicals.

Unit III

Carbohydrates:Reaction and structure elucidation of glucose and fructose, structure of sucrose and maltose- Elementary study of starch and cellulose, Industrial uses of cellulose

Amino acids, proteins and nucleic acids:L-amino acids as building block of proteins, zwitter ion property, synthesis of polypeptides-primary, secondary, tertiary, quaternary structure of proteins-Nucleic acids-structure of DNA and RNA-Genetic code-protein synthesis.

Lipids:Biological functions and types of lipids, oils and fats-occurrence in foods, compostion-industrial oils of vegetable origin-

common fatty acids present in fats and oils, extraction-refining and hydrogenation of fats and oils-identification of fats and oils-physical and chemical properties-saponification value, acid value and iodine number-flavour changes in oils and fats, reversion and rancidity.

Unit IV

Chromatography:Classification: Principle of differential migration, adsorption phenomena, Rf value. Partitition chromatography: Theory and applications; Thin layer, paper and ion exchange chromatography, liquid chromatography: HPLC – applications. Gas chromatography: Theory and application.

References:

1. Advanced Organic Chemistry, Bahl Arun, Chand & Co., N.Delhi.
2. ATB of Organic Chemistry, Mehroba Ete, Vikas Pub.
3. Organic Chemistry, Boyd Neilson Robert, Prentice Hall, N.Delhi.
4. Advanced Organic Chemistry, March Jerry, John Wiley, N.Y.
5. Organic Chemistry, Firas, Pearson Edu.

PE 1307 Industrial Chemical Analysis (lab)

1. Estimation of percentage purity of monomers – Glycerol, Formaldehyde, Methylmethacrylate, Urea, Phenol.
2. Determination of Iodine value of NR.
3. Determination of Rubber Hydrocarbon content.
4. Determination of Saponification value of oil.
5. Determination of ash content of polymer.

References:

1. Encyclopedia of Industrial Chemical Analysis, Interscience Publication, John Wiley & Sons Inc. – Foster Dee Snell, Leslie.S.Ettre
2. ASTM, BIS Standards

PE 1308 Identification of Polymers

Identification of rubbers -NR, SBR, PB, IR, IIR, EPDM, Hypalon, Thiokol, Silicone, CR, NBR.

Identification of plastics-PE, PP, PS, PVC, PVA, PF, UF, MF Polyester

Identification of thermoplastic elastomers -SIS, SBS, SEBS, Hytrel

Reference:

K.J.Saunders : Identification of Plastics and Rubber, Chapman and Hall.

SEMESTER IV

PE 1401 Applied Statistics

Unit I

Introduction to Statistics: Collection and classification, Measures of central tendency, dispersion, skewness and kurtosis.Correlation & Regression: Curve fitting by method of least squares, correlation coefficient and regression lines.

Unit II

Probability: Introduction, Addition and Multiplication Theorems, Baye's theorem, Expectation, Probability density functions and distribution functions, Moment generating functions, binomial, Poisson and Normal distribution (Theorems without proof)

Unit III

Sampling: Sampling distribution, standard error. Testing of hypothesis: Large sample and small sample tests, test for correlation coefficient, test for goodness of fit.

Statistical Quality Control: Control chart for variables and attributes, Acceptance sampling, single sampling, double sampling, Multiple sampling, sequential sampling plans, curves.

Unit IV

Design of experiments: Introduction, Randomization, replication and local control, Analysis of variance-one way and two way classification, CRD, RBD, LSD.

Concepts of quality assurance, total quality control, company wide quality control, Quality control circles, and simple statistical tool for quality circles.

References:

1. Statistical Methods: - S.P.Gupta
2. Fundamentals of Statistical Quality Control - E.L.Grant 5th Edn., Interna- tional Student Edition- MC-Graw Hill.
3. Mechanical Statistics - S.C.Gupta & V.K.Kapoor
4. Fundamental of Applied Statistics - S.C.Gupta & V.K.Kapoor.

PE 1402 Quality Management Systems and Safety

Unit I

Basis of Organisational Management, basis of quality management and quality concepts, terminology, Quality Policy, Quality Management Principles, Quality System, Quality Assurance, Quality Control, Quality Characteristics, Total Quality Management, Quality Cost, Role of Senior Management, Continual Improvement.

Unit II

ISO 9000: 2000 systems, ISO 14000, 17025 and others as applicable. Quality Auditing, introduction to internal auditing, Concept and Practice of Six Sigma, Interaction between Quality Management System and other Management Systems in an organization.

Good laboratory practices, OECD principles of GLP.

Unit III

Corrective and preventive actions, Customer satisfaction, Customer Perception of Quality, Customer Complaints, Quality of service, Customer Retention, Performance Appraisal, Benefits, Continuous

Process Improvement.

Unit IV

Introduction to Safety, Laboratory Safety, Concepts of Occupational Health Hazard and Risks, System Engineering Approach to Safety, Causes of Accidents, Accident Analysis and Control, Techniques used in Safety analysis, Safety Management and Organization, Principles and Methods of Hazard Identification and Risk Assessment, Risk Management, Training, Human Behavioral Approach in Safety.

References:

1. Dale H. Besterfiled, et al., Total Quality Management 3rd Edn., Pearson Education Ltd., U.S.A. 2003.
2. James R. Evans & William M.Lindsay, The Management and Control of Quality, 5th Edn., South-Western College Pub, USA, 2001.
3. J.S. Oakland. Total Quality Management, 3rd Edn., Butterworth– Heinemann Ltd., Oxford. 1999.
4. N S Sreenivasan, V Narayana. Quality Management - Concepts and Tasks, New Age International, New Delhi, 1996.
5. M. Zairi. Total Quality Management for Engineers, Wood Head Publishers, England, 1991.
6. David Hoyle. ISO 9000 Quality Systems Handbook, Fourth Edn. Butterworth-Heinemann, Oxford, 2001.
7. D.H. Stamatis, Six Sigma Fundamentals: A Complete Guide to the System, Methods and Tools, Productivity Press, New York, 2004.
8. Vlasta Molak, Fundamentals of Risk Analysis and Risk Management, Lewis Publishers, USA, 1997.
9. Roger L. Brauer, Safety and Health for Engineers, John Wiley& Sons, USA, 2006.

PE 1403 Polymer Synthesis and Manufacture
(2012 Revised)

Unit I

Polymer synthesis: Synthesis of speciality polymers such as aromatic polyether, polyacetals, polyamides. Polymeric liquid crystals, conducting and photo conducting polymers.

Unit II

Polymer degradation and stabilization: Thermal, oxidative, photochemical and ozone degradation, degradtion under special environments, commonly used anti-degradants, Mechanism of degradation and stabilization. Thermal analysis of polymers by DSC, TGA, DTA, DMA etc.

Unit III

Molecular characterization of polymers: molecular weight, molecular weight distribution, molecular weight determination. Branching in polymers: Short chain branches, Cross-linking (Thermoplastics and thermosets).

Determination of molecular weight and molecular weight distribution - end group analysis, colligative property measurement, light scattering, ultra centrifugation, solution viscosity and gel permeation chromatography.

Unit IV

Polymer solution - Criteria for polymer solubility conformation of dissolved polymer chains, thermodynamics of polymer solution, phase equilibria in polymer solution fractionation of polymer by solubility, swelling of cross linked polymers.

References:

1. F.W. Billmeyer - Text Book of Polymer Science-Wiley International Publishers.
2. K.J. Saunders - Organic Polymer Chemistry- Chapman and Hall Publishers.

3. R.B. Seymour & C.F.Carrher - "Polymer Chemistry" - Marcel Dekker Publications
4. Hans - George-Elias - "Macromolecules" Vol.1-Plenum Press

PE 1404 Science and Engineering of Rubbers

Unit I

General principles of rubber compounding, Mix design, Various compounding ingredients and their classification. Preparation, properties and uses of carbon black, non-black fillers, plasticizers, accelerators, activators, cross linking agents, reclaimed rubber, factice and special purpose additives.

Unit II

The chemistry and technology of rubber vulcanization – sulphur and non-sulphur curing systems.

Assessment of state of cure using various curometers, scorch and cure time.

Effect of state of cure and cure systems on the properties of the vulcanisate.

Unit III

Classification of elastomers. Manufacture, properties, processing, compounding, vulcanisation and applications of SBR, polybutadiene and polyisoprene rubber. Comparison of synthetic polyisoprene with NR. Manufacture, properties, processing, compounding, vulcanisation and applications of EVA, Polyacrylate rubbers, Polysulphide rubbers and Poly urethanes

Unit IV

Manufacture, properties, processing, compounding, vulcanisation and applications of EPDM, Butyl rubber, Nitrile rubber, Neoprene rubber, hypalon rubber, silicone rubber and Fluorocarbon rubber.

Classification of thermoplastic elastomers. Method of preparation, properties, compounding, processing and applications of thermoplastic elastomers and ionomers.

Books:

1. Rubber Technology Handbook, Werner Hofmann, Hanser Publicatios.
2. Rubber Technology and Manufacture, C M Blow, Butterworths, London.
3. Rubber Technology, Maurice Morton,3rd edition, Van Nostrand Reinhold Co., New York.
4. Science and Technology of Rubbers, Frederick R Eirich, Applied Science Publishers.

PE 1405 Thermodynamics and Reaction Engineering

Unit I

Temperature and zeroth law of thermodynamics, Energy and first law of thermodynamics, Concept of internal energy, Work and heat, Heat capacity, Entropy and second law of thermodynamics, Carnot engine

Unit II

Thermodynamic functions, Maxwell relations, Joule Thomson expansion, The third law of thermodynamics and absolute entropy, Thermodynamics of chemical reactions, Enthalpy change, Entropy change and free energy change of chemical reactions, Equilibrium constants, Effect of temperature, Le Chatelier's principle

Unit III

Phase equilibria, Clapeyron equation, Phase equilibria involving two components, Partition, Solubility product, Chemical potential, Raoult's law, Steam distillation

Unit IV

Chemical kinetics, The rate of a chemical reaction, Irreversible first order reactions, The temperature dependence of the rate constant, Irreversible second order reactions, Reversible first order reactions, Reversible second order reactions, Polymerization reactions, Batch reactors, Plug flow (tubular), Continuous stirred tank reactors (CSTR), Manufacture of polyethylene, LDPE, HDPE and LLDPE

Reference:

1) Introduction to Chemical Engineering Thermodynamics, Smith and Vannes Mc Graw Hill

2) Chemical Engineering, J M Coulson and J M Richardson, Pergamon press (1979) relevant volumes

PE1406 Plastics Materials

Unit I

Brief history of plastics - Advantages and disadvantages - thermoplastics and thermosets.

Manufacture of monomers - polymerization - structure - properties - processing and applications of polyethylene, cross-linked polyethylene, chlorinated polyethylene and polypropylene.

Preparation, properties and applications of polytetrafluoroethylene, tetrafluoroethylene copolymers, polyvinyl fluoride and polyvinylidene fluoride.

Unit II

Manufacture of monomers, polymerization and structure of poly vinyl chloride, characterization of commercial polymers, compounding ingredients, PVC formulations.

Vinylidene chloride polymers and copolymers, polyvinyl carbazole, polyvinyl pyrrolidone, polyvinyl acetate, polyvinyl alcohol, polyvinyl acetals and CI resin.

Unit III

Manufacture, properties and applications of polystyrene, HIPS, ABS plastics. Polymethyl methacrylate and other acrylic plastics. Aliphatic polyamides such as Nylon 6 and Nylon 66, aromatic polyamides, polyimides, poly carbonates, acetal resins, polyphenylene oxide, poly sulphones, cellulose ethers, cellulose esters, regenerated cellulose.

Unit IV

Manufacture of phenolic resins, preparation of phenol formaldehyde moulding powders, applications of PF resin, PF laminates.

Urea formaldehyde resin and moulding powders, applications of UF resins. Melamine formaldehyde resins and moulding powders, MF laminates. Thermoplastic polyesters, unsaturated polyester laminating resins, polyester moulding compositions, fibre and film forming polyesters.

References:

1. Plastics Materials - J.A.Brydson, Butterworth Heinmann.
2. Industrial Polymers - Ulrich, Hanser Pub. Munich, N.Y.

PE 1407 Polymer Synthesis

I Estimation of polymer molecular weights

a) Viscometry

b) Gel permeation chromatography

c) End group analysis

II Preparation of polymers

a) Polymethylmethacrylate

b) Polystyrene

c) Regeneration of cellulose

d) UF, PF, MF

e) Casting of the thermosetting resins - (a) polyester (b) Epoxy (cold set and hot set)

f) Glyptal resins

g) Preparation of polyurethane

III Grafting of polymers

a) Grafting of methylmethacrylate on NR

b) Grafting of styrene on NR

IV Polymer modification

a) Cyclised natural rubber

b) Chlorinated natural rubber

c) Liquid natural rubber

Reference:

Experimental methods in polymer chemistry - Rabek, John Wilely & sons, New York, 1998

PE 1408 Chemical Engineering Lab

1. Fluid flow measurement using orifice meter and venturimeter.
2. Weirs, notches and orifice
3. Friction in straight pipes, bends and fittings
4. Viscosity measurements by terminal setting velocity
5. Characteristic curves of a centrifugal pump
6. Calculation of heat transfer and mass transfer coefficients
7. Simple distillation and steam distillation

SEMESTER V

PE 1501 Plastics Processing

Unit I

Ease of processing of plastics compared to other engineering materials, processing and shaping techniques, primary and secondary processing, machining and joining, plastics compounding, additives and their effect, mixing: cold mixing and hot mixing, different types of mixers, plasticizing, pelletizing, size reduction. Difference in approach to processing of thermoplastics and thermosets.

Welding of plastics, different methods, machining of plastics, sawing, milling, drilling, turning, grinding and polishing

Unit II

Extrusion: Extrusion line, extruder, screw, different designs, single screw and twin screw, mixing zones, designs, ancillary equipment, sizing, cooling and product handling, film extrusion, blowing and flat film techniques, extrusion of tubing and pipe, profile extrusion, wires and cables.

Unit III

Injection moulding: Injection moulding machine, injection unit, clamping unit, toggle clamping and hydraulic clamping, moulds, process sequence, flow process within the mould, hot runner and insulated runner moulds, injection moulding of thermosets, reaction injection moulding, compression moulding and transfer moulding.

Unit IV

Blow moulding: extrusion blowing, multiple moulds, moving mould stations, parison programming, injection blow moulding. Calendaring opera tions: types of calendar, machine layouts for coating, frictioning and laminating operations. Thermoforming, positive and negative forming, rotational moulding.

Adhesive bonding of plastics, solvent cementing, recycling of plastics, mechanical recycling, feed- stock recycling, energy recover.

Books:

1. Polymer processing: D. H. Morton Jones, Chapman & Hall
2. Polymer processing Fundamentals: Tim A. Osswald, Hanser
3. Plastics Engineering, Crawford R. J., Pergamon.

PE 1502 Polymer Physics

Unit I

Chemical bonding and polymer structure-primary structure, polarity of

monomer, secondary structure, configuration, diene polymerization, tacticity, conformation, molecular weight, tertiary structure, secondary bonding forces, crystalline and amorphous structure of polymers, crystallization tendency, structural regularity, chain flexibility, polarity, bulky substituents, morphology of crystalline polymers, crystal structure of polymers, degree of crystallinity, determination of crystal structures by X-ray diffraction, crystallinity and polymer properties.

Electrical and optical properties, electrical polarization, dielectric constants surface resistivity, volume resistivity, influence of environment, resistance to tracking and electric strength, permitivity and power factor, conducting polymers, optical properties of polymers, transparency and colorlessness, refractive index.

Unit II

Thermal transitions in polymers, glass transition, theory of glass transition and measurements of glass transition temperature, kinetic theory, equilibrium theory, free Volume theory, factors affecting glass transition temperature, chain flexibility, geometric factor, inter chain attractive forces, copolymerization, molecular weight, cross linking and branching, crystallization, plasticization, the crystalline melting point, intermolecular bonding, effect of structure, chain flexibility, thermal conductivity, specific heat and latent heat of polymers, relevance in polymer processing, transient conduction, thermal diffusivity, cooling of moldings.

Unit III

Solution properties of polymers, solubility parameter, conformation of polymer chains in solution, end to end dimensions, the freely jointed chain, real polymer chain thermodynamic of polymer solutions, ideal solution, Flory Huggins theory, Flory Krigbaum theory, Osmotic pressure of polymer solution, solution viscosity, parameter for characterizing polymer solution viscosity, molecular size and intrinsic viscosity, molecular weight from intrinsic viscosity, water soluble polymers, polyelectrolytes.

Unit IV

Mechanical properties of polymers, Mechanical tests, stress-strain

behaviour, creep, stress relaxation, dynamic mechanical analysis, impact, elastic stress- strain relation, deformation of solid polymers, compression vs. tensile tests, effect of structural and environmental factors in mechanical properties, effect of molecular weight, cross-linking, crystallinty, copolymerization, plasticizers, polarity, steric factors, temperature, strain rate, pressure, polymer fracture behaviour, brittle fracture, linear elastic fracture mechanics, anisotropy.

References:

1. Brown R.P.-Physical Testing of Rubbers, Chapman & Hall
2. Brown R.P-Handbook of plastics Test Methods, Harlow, Longman Scientific and Technical, NY, Wiley 1988
3. Cowie, J.M.G,Polymers: Chemistry and Physics of Modern material, 2nd Edn., Chapman & Hall, New York.

PE 1503 Polymer Rheology

Unit I

Polymer viscoelasticity, the ideal elastic response, pure viscous flow, visco elasticity, mechanical models for linear viscoelastic response, Maxwell and Voight models, four parameter model, material response time, Deborah number, Maxwell-Weichert model, generalized Voight element, superposition principles, Boltzmann superposition, time temperature superposition, WLF equation for shift factor. Rubber elasticity, ideal rubber, entropy elasticity.

Unit II

Dynamic measurements, structure elucidation, resilience and hystersis, rebound resilience, definition for storage and loss modulus, loss tangent and complex modulus, fatigue.

Newtonian and non Newtonian flow, pseudoplastic, Bingham, dilatant and thixotropic behaviour, origin of non Newtonian flow. Factors influencing flow behaviour, molecular weight distribution, chain branching and temperature, Evaluation of processability, standard test methods for melt flow rate, flow and scorch in rubbers, methods for thermosetting materials.

Unit III

Power-law fluids, Drag flow and pressure flow of power-law fluids in simple geometries, measurement of flow properties, capillary viscometers, coaxial cylinder viscometer and cone and plate viscometer, characteristics, Rabinowitch correction, Bagley correction, extensional viscometers, melt fracture, normal stress and die swell.

Unit IV

Filler-polymer interaction, filler geometry, volume fraction filler surface, wettability, filler surface treatment, rheology, effect of polymer matrix, steady shear viscosity data. Application of rheological studies in polymer processing-extruder screw and die, analysis of pressure, drag and leakage flow, characterization and interaction of screw and die, balanced runner moulding.

Books:

1. Crawford. R - Plastic Engineering, Mc. Graw Hill.
2. Brydson. J. A - Flow properties of polymer melts - Godwin, Plastic & Rubber Institute.
3. Cogswell. F.N. -Polymer melt rheology - Godwin, John Wiley, Newyork

PE 1504 Rubber Processing and Products Manufacture

Unit I

Machinery used for mixing-two roll mills, internal mixers and continuous mixers. Master batching, blending and mixing on mills, internal mixers and continuous mixers.

Machinery used for calendering. Calendering technology. Fabric coating using calender and spreading machine.

Unit II

Machinery used for moulding. Compression, transfer and injection moulding of rubbers.

Flashless moulding, finishing of moulded articles, calculation of mould shrinkage, molding defects and its remedies.

Machinery used for extrusion. Ram and screw extruders, extrusion technology, crosshead extruders and strainers.

Vulcanisation methods other than moulding. Batch curing and continuous curing method-open steam autoclaves, hot air, fluidized bed, LCM, molten salt bath and high energy radiation curing.

Unit III

The present status and future prospects of rubber products manufacturing industry in India.

Principles of rubber compounding. Compounding to meet processing and vulcanisate properties. Reinforcement of elastomers by fillers. Factors influencing reinforcement and mechanism of reinforcement.

Compounding and manufacture of cycle tyres and tubes, solid tyres, mechanical seals, sports goods, surgical products and miscellaneous moulded, extruded and calendered rubber products.

Unit IV

Compounding techniques and manufacturing methods for the production of foot wears, conveyor and power transmission belts, hoses and tubing, rubber covered cables and wires, cellular rubber products and hard rubber products.

Compounding and manufacture of rubber to metal bonded articles including rubber covered rollers, tank, pipe and valve lining, shock absorbers and anti vibration mountings.

References:

1. Rubber Technology Handbook, Werner Hofman, Hanser Publicatios.
2. Rubber Technology and Manufacture, C M Blow, Butterworths, London.
3. Hose Tecnolgy, E W Evans, Applied Science Publishers.

4. Theory and practice of Engineering with rubbers, Freakley and Payne.

5. Textile reinforcement of elastomers, W C Wake and D B Wooten, Applied Science Publishers.

PE 1505 Fibre Science and Technology

Unit I

Definition of fibres and various textile terms, introduction on the use of fibres in rubber and plastic industry, classification and nomenclature of fibres, structure of fibre forming polymers, relation between structure and fibre properties, spinning processes; geometrical characteristics, physical, chemical and mechanical properties of fibres.

Unit II

Production, chemical composition, properties of viscose rayon, cellulose acetate, nylon 6, nylon 66, polyesters, acrylics, spandex fibres, high performance fibres – aramid, carbon, flame resistant fibres.

Unit III

Chemical composition, properties and uses of naturally occurring fibres – 1) cotton, coir, flax 2) wool, silk 3) asbestos, glass.

Fibre – matrix adhesion, improvement of bonding – bonding agents / coupling agents, modification of fibres like bleaching, grafting, chemical treatments. Principles of finishing and dyeing of man-made fibres.

Unit IV

Production of yarns and textiles – weaving, felting and knitting process. Important testing of man-made fibres. Requirements of textile for reinforcement of rubber products. Application of man made fibres including textile, agriculture, biomedical applications.

References:

1. Man made fibres – R.W.Moncrieff, Newnes-Butterworths, London.
2. Modern Textiles – Dorothy Lyle, John Wiley
3. Textiles: Fiber to Fabric- Bernard P Corbman., McGraw-Hill, New York
4. Essentials of Textiles – Marjory L Joseph, Holt Rinebert & Winston, New York
5. Textile fibres – Katherine Paddock Hess, Oxford and IBM Pat

PE 1506 Adhesives and Surface Coatings

Unit I

Adhesives-adhesive bonding-advantages-adhesive classification-basic terminology-theories of adhesion-wettability-performance of adhesives - shear, peel and cleavage properties-factors affecting adhesive performance-design of adhesive joints - selection of adhesives.

Unit II

Structural adhesive - types - epoxy, urethane, acrylic, phenolic and high temperature and PVC plastisol types, advantages and disadvantages - anaerobic adhesives-cyanoacrylates-hot melt adhesive-pressure sensitive adhesives-silicone adhesives-water based adhesives-inorganic adhesives.

Unit III

Bonding practice-surface preparation technique-methods of application of adhesives-adhesives for specific substrates-testing methods for adhesives- shear, peel, cleavage, tension and tack-specifications and quality control.

Unit IV

Pigments and paints-inorganic pigments-organic pigments-extenders-paint preparation factors affecting dispersion-preparation of pigment dispersion- surface preparation and paint application techniques.

Paint properties and their evaluation-mechanism of film formation-

factors affecting coating proprieties, methods used for film preparation, carrier properties, optical properties, ageing properties, rheological properties and adhesion properties of coatings.

References:

1. Adhesives in manufacturing, Gerald L.Schnberger, Marcel Dekker Inc., New York, (1983)
2. Adhesion and the formulation of adhesives, W.C.Wake, Applied Science Publishers, London (1976)
3. Surface coatings, Swaraj Paul, John Wiley & Sons (1985)

PE 1507 Polymer Characterization and Properties

1. Demonstration of equipments like UTM, TGA, DSC, ODR, UV, GPC etc.
2. Determination of MFI of plastic materials
3. Determination of viscosity using Brookfield viscometer
4. Determination of MST, HST, and ZST of latex
5. Preparation of test pieces
6. Determination of tensile strength and tear strength of rubber and plastic samples.
7. Determination of Resilience, Abrasion Resistance, Flex, Crack Resistance, Compression set, Heat build up, Heat deflection temperature, Hardness.

References:

BIS, ASTM, ISO Standards

PE 1508 Polymer Processing

1. Estimation of percentage purity of MBT, DPG, ZnO
2. Determination of acid value of stearic acid
3. Determination of Iodine Adsorption number of Carbon black.

4. Analysis of rubber compounds:

    Carbon black content

    Free sulphur content

    Total inorganic filler and silica content

    Total sulphur content

    Bound rubber content

    Determination of mooney viscosity, scorch time and cure time

5. Estimation of flash point and fire point of oils.
6. Estimation of Aniline point of oils.
7. Estimation of pour point of wax.

Product manufacture:

1. Preparation of rubber products like play balls, injection bottle caps, teats, tea-mats, M.C.Sheet, Vstraps, sponge, rubber to metal bonded article, solvent based adhesive etc.
2. FRP laminate by hand lay up.
3. Production of plastic products using injection moulding, extrusion, blow moulding etc.

References:

1. ASTM and BIS standards.
2. Rubber Technology and Manufacture: C.M.Blow, Butterworths, London.

Factory visits:

a) Visit to rubber factories producing extruded and moulded articles.

b) Visit to units manufacturing FRP products

PE 1509 Review Seminar

Each student will have to present a seminar on a selected research topic

SEMESTER VI

PE 1601 Latex Technology

Unit I

Comparative study of rubber goods manufactured from latices and solid elastomers. Comparison of natural and synthetic latices. Latex properties and test methods for TSC, DRC, mechanical stability, chemical stability, KOH No., VFA No., sludge content, coagulum content.

Unit II

Colloid stability and destabilization of latex. Destabilization by physical and chemical means.

Latex compounding ingredients-vulcanizing agents, accelerators, activators, fillers, surface active substances, anti oxidants etc.

Principles of latex compounding. Preparation of dispersions and emulsions. Latex spreading combining and doubling. Different methods. Typical spreading compounds. Latex carpet backing. Latex based surface coatings. Latex adhesives for paper, leather, metals, ceramics, plastics, glass, Latex based rubber to textile bonding adhesives like RFL. Use of latex in road surfacing

Unit III

Latex dipping: The principle dipping methods-Simple dipping, Coacervant dipping - Heat sensitized dipping, Electro deposition. Production of articles by dipping, after treatments, defects-causes and remedies. Design of latex compounds for dipped goods.

Latex thread: Details of extrusion process. Typical thread formulation.

Unit IV

Latex foam rubber: General principles of latex foam production. The Dunlop process, batch foaming and continuous foaming process. Typical formulation for latex foam production. The Talalay process for foam manufacture. Physical properties of foam rubber.

Moulding and casting: Slush moulding and rotational moulding, moulding using plaster of paris moulds and metal moulds. Typical formulation for moulding.

References:

1. D.C.Blackley - "Polymer Latices" 2nd edition. Volume I, II & III Applied Science Publishers, London.
2. K.O.Calvert - "Polymer Latices and their Applications". Applied Science Publishers, London.
3. E.W.Madge - "Latex Foam Rubber". MaxLauren & Sons, London.

PE 1602 Characterisation and Testing Methods

Unit I

Introduction to standard organizations like BIS, ASTM, ISO, BS, DIN etc. Their importance in the quality control of polymers and polymer products. Preparation of test pieces, conditioning and test atmospheres.

Thermal analysis techniques like DTA,DSC,TGA etc. Spectroscopic techniques like IR, UV, NMR etc. Application of these techniques to polymers.

Unit II

Specification and tests prescribed for NR latex and dry rubber.

Important processability tests carried out on thermoplastics and thermosets – MFI, cup flow index, viscosity, M.P, gel time, bulk density, bulk factor etc

Tests for processability parameters of rubbers – plasticity, mooney viscosity, scorch time, cure time, cure rate index etc.

Unit III

Mechanical properties of plastics and rubber – tension, compression, shear, flexural, tear strength, dynamic stress- strain, hardness, impact strength, resilience, abrasion resistance, creep and stress relaxation, compression set, dynamic fatigue, ageing properties etc.

Thermal properties – specific heat, thermal conductivity, thermal expansion, heat deflection temperature etc.

Electrical properties – resistivity, dielectric strength, dielectric constant etc.

Optical properties – transparency, refractive index, haze, gloss etc

Unit IV

Testing of latex products- dipped goods, foam, latex thread etc

Testing of dry rubber products – footwear, hoses, belt, tyres, tubes etc

Testing of plastic products – containers, pipes, films, laminates etc

References:

1. ISO, BIS, ASTM, BS and DIN standards.
2. R.P.Brown - Plastic test methods, Harlond, Longman Scientific
3. Vishu Shah - Handbook of Plastic Testing Technology, John Wiley & Sons, New York 1998
4. R.P.Brown - Physical Testing of Rubbers, Chapman hall, London, 1996.
5. J.F.Rabek - Experimental methods in Polymer Chemistry, John Wiley & Sons, New York.
6. F.Majewska, H.Zowall etal - Handbook of analysis of

synthetic poly- mers and plastics, Ellis Horwood Limited Publisher, England, 1977.

7. C.A. Harper - Handbook of Plastics Elastomers & Composites, 2nd edi- tion, McGraw Hill Inc. New York 1992.

PE 1603 Polymer Products Design

Unit I

Introduction: Steps in Polymer product design. Design principles, Functional design, aesthetic design, plastics structure, physical and chemical properties, effect of fillers on properties and performance.

Stress Analysis: Stress in products - Tension, compression and shear, Elastic constants, factors of safety, working stress, safe stress, bending and torsion, combined stress, stress concentration, Endurance limit, Fatigue factors, structural design of beams, plates and other structural members, Dynamic load response and effect of cyclic loading, Design for stiffness, Processing limitations on product design, Design of products for static and dynamic loads, Design for electrical and optical applications, service performance, cost estimation, cost reduction methods.

Unit II

Design Features: Inside sharp corners, Uniform wall thickness, Ribs, Tapers or draft angles, other features -Weld lines, gate size and location, wall thickness, tolerance, moulded inserts, Internal plastic threads, Blind holes, Undercuts, Thermoplastic hinge, Functional surfaces and lettering, Tolerances, Snap fitting, welding.

Unit III

Products: Gears-introduction, Advantages and disadvantages of plastics gearing, Glossary of gearing terms, Design, Backlash and working clearance, Materials, Lubricating additives, Frictional and wear properties, strength and durability, Moulded Vs cut plastic gearing, inspection, Assembly and operation. Bearings-Introduction, self lubricated plastic materials, rubber bearings, types of bearings, designer's checklist, Test machines, wear surfaces. Piping-

Introduction, selection of materials, processing, design factors, Di- mensions and specifications, Methods of joining, Manholes, Assembling, Pump pressure, External loading, Quality control and Costing, Pressure pipe -Pressure rating calculation, Static loads in buried pipes, crack propagation.

Unit IV

Design of Rubber Products: Physical properties of rubber, short term stress-strain behaviour, Dynamic properties, Hysteresis, Energy absorption, Energy dissipation, Damping capacity, Heat build-up, Fatigue failure.

Vibration Dampers: Principles of vibration, simple harmonic motion, combination of two simple harmonic motions, beats, periodic motion, system with single degree of freedom, undamped vibration, natural frequency, torsional vibrations, damped vibrations, octave rules, viscous, coulomb and solid damping, frequency of damped vibrations, logarithmic decrements, critical damping, forced vibrations, with and without damping, systems with two degree of freedom, multi degree of freedom. Vibration isolation-dynamic, periodic isolation and transmissibility, isolation of shock and transient vibrations, use of rubber in mountings and bridge bearings.

References:

1. Freakly and Payne. "Theory and Practice of Engineering with Rubber", Applied Science, London 1978.
2. Hepbum and Reynolds, "Elastomers-Criteria for Engineering Design", Applied Sciences, London 1979.
3. Designing plastic parts for Assembly - P.A.Tres, Hanser.
4. Product Design with Plastics - J.B.Dym, Industrial Press Inc. New York, 1983.
5. Plastic Product Design - R.D.Beck, Van Nostrand Reinhold Company, New York, 1980.
6. Engg. Design - A systematic approach - R.Matousek.

PE 1604 Polymer Composites and Blends

Unit I

Introduction to composite materials - classification - advantages - polymer composites - reinforcement fibres - glass, carbon, kevlar, boron, silicon carbide - composition-manufacture - surface treatment for glass fibres-coupling agents - particulate and flake reinforcement. Polymer blends - importance, plastic - plastic, rubber-rubber and plastic-rubber blends-miscibility and compatibility, methods of determining mis- cibility/compatibility, compatibilising agents, processing of polymer blends.

Unit II

Matrix materials - classification - thermoset, thermoplastic and elastomeric materials - UPR, epoxy, phenolic, polyurethane, silicone, PE, PP, ABS, Nylon, NR, SBR, NBR, CR matrices - properties and characteristics.

Unit III

FRP processing - important methods - hand lay up, spray up, filament winding, compression moulding, injection moulding, resin transfer moulding, reaction injection moulding, pultrusion, miscellaneous methods - machinery, operation, advantages and disadvantages.

Unit IV

Theory of composite materials - calculation of composite properties-mechanism of load transfer, minimum and critical fibre content, critical fibre length- law of mixtures – Halpin -Tsai - equation.

Reference:

1. Polymer Composites – from Nano to Macro scale, Friedrich K., Fakirov S. and Zhang Z.(Eds.), Springer Science + Business Media, Inc., 233 Spring Street, New York, NY 10013, USA (2005).
2. Polymer Engineering Composites. Ed.M.O.W.Richardson, Applied Science Publishers, London.

3. Handbook of composites, G.Lubin, Van Nostrand, New York, 1982
4. Mohr J.G. et al SPI Handbook of Technology and Engineering of Reinforced Plastics/Composites, Van Nostrand, New York.
5. Polymer Blends, Paul D.R.and Newman S. Academic Press.

PE 1605 Polymers for Electrical & Electronics Applications

Unit I

Organic semiconductors – phthalocyanines, microcyanine, (SN)x, chlorophyll. Difference between inorganic semiconductors and organic semiconductors.

conjugated polymers- Historical development,Basic structural characteristics of conjugated polymers. Important properties of conjugated polymers- electrical conductivity, photoconductivity, charge storage capacity, photoluminescence, and electroluminescence.

Applications of conducting polymers- electro active applications- Polymer rechargeable batteries, sensors, electrochemical actuators, electro luminescent applications.

Conductivity applications - antistatic coatings, conducting adhesives, artificial nerves.

Electronic applications- EMI shielding, Frequency selective surfaces, satellite communication links.

Unit II

Electrically conducting polymers- Chain growth polymerisation, step growth polymerization, electrochemical polymerization, Metathesis polymerization(Ring opening metathesis polymer (ROMP). Advantages and disadvantages of conducting polymers, methods to enhance the processability of conducting polymers.

Unit III

Synthesis and properties of conducting polymers-Polyacetylene, Poly p-phenylene, Polyheterocyclic and polyaromatic conducting polymers

like polythiophene, poly vinyl carbazole, polypyrene, polyaniline, Polypyrrole, Poly phenylene vinylene, Polypyridine.

Unit IV

Valence Band theory- basic concepts of band model, band model of conductor, semiconductor and insulator. Carrier mobility, intrachain conductivity, interchain conductivity.

Concept of doping- Charge carriers: polarons, bipolarons and solitons. Types of dopants, oxidative dopants and reductive dopants, mechanism of doping, p-type doping and n-type doping, inorganic and organic dopants, effect of doping on the dielectric properties of conducting polymers

Dielectric properties of conducting polymers in the high and very high frequency fields (a.c field), ultra high frequency field (Microwave field). Dielectric constant, dielectric loss and absorption property of conducting polymers in the a.c and microwave fields.

References:

1. T. A. Skotheim, R.L. Elsenbaumer, J.R. Reynolds, Hand book of conducting polymers, 2ed. Marcel Dekker, New york, vol.1-2., (1998).
2. H.S. Naiwa, organic conductive molecules and polymers, John wiley and sons; vol. 2, England (1977).
3. J. L. Bredas, R. Silbey, conjugated polymers, kluwer, Dordrecht, (1991).
4. Encyclopaedia of Polymer science and Engineering, second edition, Vol.5, Mark Bikales over Berger Menges John Wiley and Sons Inc., (1986).
5. M.E.O.Lyons, Electroactive polymers, Ed;Plenum Press; New York, PP 1-65, (1994).
6. J. Margolis, Conducting Polymers and Plastics, Chapman and Hal, London 1993.

PE 1606 ELECTIVE I

PE 1606 A Polymers for Packaging

Unit I

Edible and biobased food packaging materials, Edible film and coating, Polysaccharide based coatings, Lipid based coatings, Protein based coating, First, Second and Third biobased packaging materials.

Unit II

Permeability of thermoplastic polymers, Multilayer films, Processing, Deteriorative reaction in foods, Enzyme reactions, Chemical reactions, Physical change, Biological change, shelf life of foods, Factors controlling shelf life.

Unit III

Asceptic packaging of foods, Sterilization of packaging materials, Packaging of microwavable foods, Active and intelligent packaging, Modified atmospheric packaging, Packaging of fresh foods, Packaging of horticultural products.

Unit IV

Packaging of dairy products, Packaging of cereals, snack foods and confectionary, Packaging of beverages, Comparison of polymer packaging with paper, metal and glass materials, printing processes, safety and legislative aspects of packaging.

Books

1) Food Packaging – Gordon.L Robertson, Taylor and Francis (2006).

2) Plastics packaging RJ Hernandez /Susan EM Selhe John D Caller, Hauer Publishers.

PE 1606 B Polymer Process Modeling and Simulation

Unit I

Extrusion-general features-mechanism and analysis of flow-leakage-power requirements-analysis of film blowing and blow moulding.

Unit II

Injection moulding-general features-screws, nozzles and moulds-mould clamping force-heat transfer in polymers-estimation of mould cooling time and flow length.

Unit III

Compression moulding-general features-analysis-thermoforming, rotational moulding and calendering-analysis

Unit IV

Modelling of polymer melt flow-isothermal flow of Newtonian and power law fluids through different channels of uniform cross-section

References:

1. Plastics processing by R.J.Crawford; Maxwell Macmillan International Edition, Pergamon Press
2. Polymer processing by D.H.Morton-Jones; Chapman and Hall

PE 1606 C Polymers for Biomedical Applications

Unit I

Introduction to classes of materials used in medicine, world-wide market for biomaterials, clinical implications of biomaterials development.

Types of materials-inert, toxic, bioactive, natural materials - collagen, biopolymers etc.

Introduction to biocompatibility, requirements and standards, cell-material interaction, testing of biomaterials, in vitro assessment, in vivo assessment of tissue compatibility, testing of blood-materials interaction, animal models.

Unit II

Polymers as biomaterials, silicones, polyurethanes, polyvinyl chloride, polyethylenes, ultra high molecular weight polyethylene, polyacrylates, polyether ether ketone, water soluble polymers, hydrogels, bio-adhesives, diffusion principles, polymers for controlled drug delivery applications, polysaccharides, poly(orthoesters), polyanhydrides, aminoacid derived polymers, polyphosphazenes, bacterial polyesters, etc.

Concepts of polymer composites, composites - reinforcing systems-fabrication, mechanical properties, dental filling composites, fibrous and particulate composites in orthopedic implants.

Biomimetic materials, nanoscale materials/engineering; bioactive/ bioresponsive materials, polymer scaffolds, principles of tissue engineering.

Unit III

Medical devices, medical device development, material choice, device design, extracorporeal devices, oxygenators, intravenous catheters, stents, polymeric implants, heart valves, total artificial heart, cardiac pace makers, vascular grafts, artificial kidney, dialysis membranes, hard tissue implants, orthopedic implants, fracture plates, intramedullary devices, spinal fixation, joint replacements, bone cement, soft tissue replacements, wound dressing, artificial skin, sutures, contact lenses, tissue adhesives, maxillofacial implants, ear and eye implants, controlled drug delivery systems, biosensors, gloves, condoms, urinary catheters, intrauterine systems, cosmetic implants.

Regulation and standards for quality, FDA, EU-medical directives, GMP, GLP, ISO, CE marking etc.

Unit IV

Degradation of polymers in biological environments, biodegradable polymers, polylactic acid, polyglycolic acid, polylactic acid co-glycolic acid, polycaprolactone, hydrolysis, enzymatic degradation.

Surface modification techniques, plasma modifications, coating methods.

Sterilization, methods, dry heat, steam, ethylene oxide, gamma ray, effect of sterilization on polymers, importance of packaging, shelf-life.

References:

1. Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen and Jack E. Lemons, Biomaterials Science, An introduction to Materials Science, 2nd Edn, Elsevier Academic Press, London, 2004.

2. J. Park and R.S.Lakes, Biomaterials An Introduction, 3rd Edn., Springer Science, New York, 2007.

3. F.Silver and C. Doillon, Biocompatibility, Interactions of biologicals and Implantable Materials Volume 1. Polymers, VCH Publishers, New York, 1989.

4. Shalaby W. Shalaby, Biomedical Polymers, Designed to degrade systems, Hanser Publishers, New York, 1994.

5. D.L.Wise et al. Eds., Encyclopedic handbook of Biomaterials and Bioengineering, Part A. Materials & part B. Applications, Volume 1 &2,., Marcel Dekker Inc., New York, 1995.

PE 1606 D Disaster Management

Unit I

Introduction to Disasters: concepts, and definitions (Disaster, Hazard, Vulnerability, Resilience, Risks). Disasters: clasification, causes, and impacts (including social, economic, political, environmental, health, psychosocial, etc.). Differential impacts- in terms of caste, class, gender, age, location, and disability. Global trends in disasters: urban disasters, pandemics, complex emergencies, and climate change.

Unit II

Approches to disaster risk reduction (DRR): Disaster cycle - analysis and phase, Culture of safety. Mitigation and prevention of disasters. Preparedness for community based DRR: Structural- nonstructural measures. Roles and responsibilities of community, Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), State Governments,

Central Government, and other stake-holders. Disaster Risk Management in India. Hazard and vulnerability profile of India.

Unit III

Inter-relationship between disasters and development. Factors affecting vulnerabilities: impact of development projects such as dams, embankments and changes in land-use. Climate change adaptation. Relevance of indigenous knowledge, appropriate technology and local resources. Components of disaster relief: water, food, sanitation, shelter, health and waste management. Institutional arrangements such as mitigation, response and preparedness, DM Act and policy, and other related policies, plans, programmes and legislation.

Unit IV

Students (in groups of four) have to carry out a mini project (as a field work/case study), preferably in Kochi city, on reducing disaster risks based on the guidance given by a faculty member. The mini project may include mapping of disaster prone geographic areas/industrial operations and preparation of a suitable disaster management plan.

References:

1. Roger L. Brauer, Safety and Health for Engineers, John Wiley & Sons USA, 2006.
2. Alexander David, Introduction in 'Confronting Catastrophe', Oxford University Press, 2000.
3. Andharia J., Vulnerability in Disaster Discourse, JTCDM, Tata Institute of Social Sciences Working Papwer No. 8, 2008.
4. Disaster Management: A Disaster Manager's Handbook. Asian Development Bank.
5. Disaster Management Act 2005, Government of India, New Delhi.
6. National Disaster Management Policy Government of India, 2009.

PE 1607 Minor Project and Seminar

Students will have to take up a mini project in groups of two based on a problem suggested by a faculty member. The work should be completed by the end of the 6th semester. The report must be submitted as bound volume to the department for evaluation.

The students individually will prepare and present a seminar on a subject of their choice. The presentation material will have to be submitted to the department as bound volume.

PE 1608 Latex Technology Practical

1. Preparation of dispersions and emulsions.
2. Creaming of natural rubber field latex
3. Effect of viscosity modifier on thickness of latex deposits.
4. Heat sensitized dipping.
5. Preparation of SP rubber.
6. Preparation and testing of CV and LV rubber.
7. Preparation of rubber bands, balloons, finger caps, household and surgeons gloves, latex foam, latex based adhesives.
8. Production of rubber articles by casting.

Factory visits:

Visit to units producing dipped goods, latex foam, carpet backing, latex thread and other latex products.

References:

High Polymer Latices - D.C.Blackely, Vol. I & II Applied Science Publishing, London.

SEMESTER VII

PE 1701 Polymers and Environment

Unit I

Environmental issues related to polymer industry, Design for environment, Life cycle approach, Contribution to energy, feedstock, transport, Gross and net calorific values.

Unit II

Polymers in packaging, Common packaging plastics, Bio degradable plastics, Source reduction, Reuse and recycling.

Unit III

Polymers in agriculture, Greenhouse films, Plastics in Mulch films, Plastics in silage, Disposal of waste plastic films, Drip irrigation system.

Unit IV

Flammability of polymers, Release of polymer vapours, Ignition, Combustion of polymer vapours, Fire propogation, Thermal destruction of waste plastics.

Books:

1) Plastics and the environment – Anthony L. Andrady, Wiley Interscience, 2003.

2) Polymers, the environment and sustainable development, Ian Hamerton, John Wiley and Sons, 2003.

PE 1702 Introduction to Mould and Die Design

Unit I

Introduction to common fabricating machinery employed for mould making-lathes, milling machines, boring machines, grinding machines etc. - electrode discharge machining - materials for mould making.

Unit II

Injection moulding process and mould-construction-cavities and inserts- bolsters-ancillary items-ejection techniques-advantages and disadvantages.

Feed system various types of runner and gate designs advantages and disadvantages. Balanced runner and gate system-venting-mould cooling-three plate moulds.

Unit III

Extrusion dies-important aspects of die design-flow of plastic melts-land length-entry geometry-features of typical tube extrusion die, ancillary items- dies for various applications.

Unit IV

Compression moulds-types of moulds-features-principles of mould making for transfer moulding, rotational moulding, reactive processing and blow moulding.

References:

1. Injection mould design, R.C.W.Pye, George Godwin.
2. Extrusion of plastics, E.G.Fisher, Newnes-Butterworths.
3. Plastic mould engineering handbook, J.Harry Dubois and Wayne 1. Pribh, Van Nostrand Reinhold Company.
4. How to make injection moulds- Georg Menges, Walter Michaelin and Paul Mohren, Hanser Publishers, Munich.

PE 1703 Failure Analysis of Polymers

Unit I

Fracture mechanics, Fracture predictions based on the stress intensity factor, Fracture predictions based on an energy balance, Linear viscoelastic fracture predictions based on J- integrals, Short term tensile strength, Brittle failure, Ductile failure, Failure of highly filled systems or composites.

Unit II

Impact strength, Impact test method, Fracture mechanics analysis of impact failure, Creep rupture, creep rupture tests, Fracture mechanics analysis of creep rupture, fatigue, fatigue test method, friction and wear, Stability of polymer structures, Environmental effect on polymer failure, Weathering, Chemical degradation, Thermal degradation.

Unit III

Failure analysis, Identification of strategic weakness, Thermo oxidation, Stabilising additive metal catalysis, Influence of stress, oxidizing medium, Photo oxidation, the severity of exposure, stabilisation.

Unit IV

Degradation due to ionizing radiation, Degradation mechanisms, Chemical attack, hydrolysis, Environmental stress cracking, crazing and cracking in air, Electrical treeing and water treeing, electrochemical degradation, Bio degradation microorganisms, diffusion, permeation and migration, Physical ageing.

References:

Failure of Plastics and Rubber Products, David Wright- RAPRA Technology Ltd, (2001).

PE1704 Industrial Management

Unit I

Definition of management, characteristics of management, levels of management, management skills. Evolution of management theory, scientific management, principles of scientific management, administrative management, modern management theories. Functions of management, planning, forecasting, organizing, staffing, directing, motivating, controlling, coordinating, communicating, decision making.

Unit II

Personnel management - definitions, objectives, characteristics, functions, principles, Recruitment and selection of manpower, scientific selection, transfers, promotion, absenteeism, labour turnover. Training and development of manpower, need, objectives, benefits, methods.

Unit III

Production management, manufacturing systems, product design and development, plant location and layout, balancing production lines. Materials management, purchasing, stores and store-keeping-inventory control. Quality management-definition, QC function, quality systems, quality control, quality cost, accounting for quality cost and loss, quality audit.

Unit IV

Marketing management-Evolution of marketing, modern concept of marketing-marketing functions-marketing systems, marketing mix, consumer behaviour, products mix, product line, advertising, pricing, market research, sales forecasting.

Functions of financial management, cost accounting and control, fundamentals of accounting. Balance sheet, source of finance, financial institutions, Profit/loss account, cost of sales taxes. Financial ratio, capital classification of capital, working capital, need for working capital, assessment of working capital, factors affecting working capital. Breakeven analysis, depreciation, equipment replacement policy.

References:

1. Industrial Organisation and Management : Bethel, Mc Graw Hill
2. Principles of Industrial management : Koonz & Doel
3. Financial Management : Prasanna Chandra, Tata Mc Graw Hill
4. Operation Management : Fabricky et al, Tata Mc Graw Hill
5. Hand book of MbO : Reddin & Rayan, Tata Mc Graw Hill

6. Projects : Prasanna Chandra, Tata Mc Graw Hill
7. Industrial finance of India : S.K.Basu
8. First steps in book keeping : J.B.Batiliboi
9. Management accounting : Hingrani & Bemnath
10. Production and Operations management Manufacturing and Service : Chase, Aquilano, Jacobs, Irwin, Mc Graw Hill
11. Project Management - A managerial Approach : Jack R Meredith, Samuel.J.Mantel.Jr.
12. The essentials of Project Management : Dennis Lock, Gower Publishing Limited.
13. Organization Theory : Mary Jo Hatch, Oxford University Press

PE 1705 Tyre Technology

Unit I

A historical introduction to the design and development of various types of tyres. The current status of tyre industry in India. Tyre sizing and marking on tyres. Different types of tyres, bias, bias belted radial tubed and tubeless tyres, their basic features and performance comparison. Basic functions of a pneumatic tyre. Different components of a tyre, its geometry and functions.

Unit II

Manufacturing techniques of various tyres like two wheeler, car tyres truck tyres, OTR farm tyres and air craft tyres. Principles of designing compound formulation for various components. Tyre reinforcement materials, their selection criteria, different styles and construction, textile treatment. Green tyre design principles. Method of building bias belted, radial and tubeless tyres, green tyre treatments. Tyre curing methods, Post cure inflation, quality control tests. Manufacturing techniques of various tyre related products like tubes, valves, flaps & bladders. Different features and operations of tyre building machines.

Unit III

Cord rubber composites, its properties, failure mechanism. Tyre cord

to rubber bonding: dry bonding and wet bonding systems. Textile materials used in tyres: A comparative study - Tyre cord dipping process. Mechanics of tyre pavement interaction.

Tyre forces on wet and dry roads, ice, snow and irregular pavements. Braking and traction tyres.

Unit IV

Tyre wear, rubber friction and sliding mechanism, various factors affecting friction and sliding. Tyre stress and deformation, tyre noise generation, effect of tread pattern, vehicle speed etc. on noise level, tyre in plane dynamics. High frequency properties, tyre balancing.

Measurement of tyre properties, dimension and size under static and loaded condition. Tyre construction analysis, Endurance test, wheel and plunger test, traction, noise measurement. Force and moment characteristics, cornering coefficient, self aligning torque, load sensitivity and load transfer sensitivity, rolling resistance, non uniformity, dimensional variations, force variations, radical and lateral tyre balance, mileage evaluation. Tyre flaws and separations. Non destructive testings like X ray, Holography, etc. BIS standards for tyres, tubes and flaps.

Reference:

1. Tyre Science & Technology (Journal of the Tyre Society) Akron, Ohio
2. Tyre Technology 'Tom French' Adam Hilger, New York.
3. Tyre Mechanics & Testing (Sponsored Course notes) Feb. 83 Roorkee
4. Mechanics of pneumatic tyres, 'Samuel Clark'.
5. Tyre valve & Rimdate ITTAL New York.
6. LJK Setright, Automobile Tyres, Chapman and Hall, London.
7. F.J.Kovac- Tyre Technology, 4th edition, The Goodyear Tyre & Rubber Company.

PE 1706 ELECTIVE II

PE 1706 A. Polymers in Space

Unit I

Polymers for aerospace research- adhesives, coatings, ablatives. Synthesis and processing of advanced thermoplastics, PEEK, polycarbonates, Polyethers, Polyethersulphones. Synthesis and processing of thermal protection systems in space research High temperature resistant resins such as epoxy, phenolic and polyimides. High temperature resistant polymers with metals in their back bone - Boron, Silicon and Phosphorous containg polymers for space applications

Unit II

Composites for satellites and launch vehicles: Composites- type of composites- fibre composites, particulate composites, foam composites. Desired Properties of a Polymer Matrix - Thermosets and Thermoplastics. Fiber reinforced Polymer (FRP)-Types of fibers, Mechanical properties of fibers, Glass fibers, Carbon fibers, Aramid fibers, Metal fibers, Alumina fibers, Boron Fibers, Silicon carbide fibers, Silica fibers, etc. Theory of reinforcement, property depending on resin and reinforcement, directional properties. Laminated composites- Lamina & Laminate Lay-up, Ply-orientation definition. Strength of Laminates, Laminate Stiffness, Special Classification of Laminates, symmetric, anti-symmetric and non-symmetric laminates

Unit III

Testing of Composites-Mechanical testing of composites, Tensile testing, Compressive testing, Intralaminar shear testing, Interlaminar shear testing, Fracture testing etc. Joining of composites Adhesively Bonded Joints & Mechanically Fastened Joints, Environmental Effects on composites.

Composite characterization by mechanical, thermal and DMTA techniques. Failure mechanics of Composites.

Unit IV

Propellant binders: Classification of propellants- solids, liquids, hybrid, air breathing. Solid propellants – Homogenous smokeless propellants, Heterogeneous (composite) Propellants. High energy binders- synthesis, characteristics, applications. Glycidyl azide polymer and its homologues, Polynitro methyl oxetane, Poly glycol nitrates.

References:

1. S-C Lin, E.M. Pearce, High Performance Thermosets, Chemistry, Properties and Applications, Hanser Publications NewYork, 1993
2. C. A. Dostal etal. Engineered Materials Handbook vol 3 Adhesives and sealants, 1990.
3. S. K. Mazundar Composites manufacturing materials, product and process engineering CRC press, Boca Ratun 2002
4. Polymer Composites – from Nano to Macro scale, Friedrich K., Fakirov S. and Zhang Z.(Eds.), Springer Science + Business Media, Inc., 233 Spring Street, New York, NY 10013, USA (2005).
5. Urbensky, Chemistry and Technology of Explosives, Vol.2, Vol.3 and Vol.4, Pergamon Press, New York, 1985.
6. Boyars.C and Klager. K., Propellants manufacture, Hazards and Testing, Advances in Chemistry Series, American Chemical society, Vol.88, Washington D.C., 1969.

PE 1706 B. Polymer Nano-composites

Unit I

Introduction to composite materials – Classification, Introduction to polymer composites – Nano, micro and macro scales – Reinforcements – Short fibre, long fibre and particulate fillers – Matrices – thermoplastics-thermosets and rubbers- Nano and micro composites- Short and long fibre composites- Treatment of reinforcements- Polymer-filler interactions-Use of coupling and bonding agents.

Unit II

Incorporation of reinforcements in polymer solution mixing- latex stage mixing-melt mixing and in-situ polymerization and precipitation – Dispersion and nucleating effects-Intercalation and exfoliation-Application of layered and nonlayered nano and micro particles in polymer modification-Preparation of long fibre and short fibre composites Different methods of preparation of composites.

Unit III

Carbon nanotubes- single walled and multi walled- preparation, treatment and functionalization-Salient features of polymer modification with carbon nanotubes- nano silica and nano clay-Organically modified layered clays: various methods used for the incorporation of nano fillers in polymer matrix like solution mixing, latex stage mixing and melt mixing.

Unit IV

Characterization and testing of polymers and polymer composites-Thermal, mechanical and electrical properties- tribological characteristics- Fracture behaviour- Creep and Fatigue behaviour-Composite material rheology. Long term effects- Applications of composites.

References:

1. Polymer Composites – from Nano to Macro scale, Friedrich K., Fakirov S. and Zhang Z.(Eds.), Springer Science + Business Media, Inc., 233 Spring Street, New York, NY 10013, USA (2005).
2. G. Lubin - Handbook of composites – (Van Nostrand, 1982)
3. M.O.W. Richarson - Polymer Engineering Composites – (Applied Science Publishers,1995)
4. J. G. Mohr - SPIE Handbook of Technology and Engineering of Reinforced Plastics/Composites – (Van Nostrand,1998)
5. R. Krishnamoorti and R.A. Vaia – Polymer nanocomposites: Synthesis characterization and modelling (Americal Chemical Society, 2002)

6. Pinnavaia T.J. and Beall G.W. – Polymer –clay Nanocomposites (John Wiley 2000)

PE 1706 C. CAD/CAM in Polymer Processing

Unit I

Introduction to computer systems, Hardware, software. Comparison between conventional drafting and computer drafting, Advantages and applications. Softwares and peripherals used to implement CADD.

Introduction to Auto CAD interface, drawing setup, categorization of commands-concepts of entities, objects and complex entities, basic drawing commands (point, line, circle etc.) and systems variables.

Editing commands, object selection methods, object snapping, productivity tools, layers, blocks, design centre, hatches, dimensions and annotations.

Unit II

Introduction to 3D Space-Concept of view point, point filters, object filters, modelling techniques-surface modelling-surface fitting commands - solid modelling - primitive modelling - profile based modelling (extrusion, revolution etc.) Boolean Solids, solid editing commands-fillet, chamfer, slice, section and sub object solid editing. Mass-property analysis. Alternate views - oblique, isometric, orthographic and perspective views.

Unit III

Presentation techniques - concept of scripts, slide show, rendering, steps to create a 3D scene. Lights, cameras and materials. Hard copy generation methods, concept of viewport, model space and paper space. Adding hyperlinks, making drawings and designs, WEB compatible, generating an e-plot.

Unit IV

Parametric programming - Introduction to Auto LISP, local and global variables concept of expressions, lists, forms, function for assignment, iteration, control structures, recursion, arrays, list and selection set manipulation. Parametric programming Units- getinfo/

processinfo/output. Sample program and assignments related with die and mould design. Debugging tools and Visual LISP editor.

Text Books:

1. Mastering Auto CAD 2002 by George Omura BPB Publication.
2. Inside Auto CAD 2002 New Readers Publishers.
3. ABC's old Auto LISP by George Omura, BPB Publication.
4. Autolisp Unofficial Guide by Vijay Mughi.

PE 1707 Polymer Product Testing

1. Testing of Latex products
   Gloves Thread Foam
2. Testing of Dry Rubber Products
   Sponge, MC sheet
   Tubings
   Rubber to metal bonded products
   Hoses
   Belting
3. Testing of Plastic Products
   Films, Sheets Pipes Laminates
   Blow Moulded Containers

References:

ASTM, ISO, BIS Standards.

PE 1708 Elective Based Seminar

Each student will have to select a topic from the elective subjects and have to prepare a detailed presentation and give a seminar on it.

SEMESTER VIII

Project work & Industrial training shall be for a period of 5 months. Students shall be attached to one or more leading polymer industries or research institutions.

PE 1801 Project Work Report and Viva Voce

Each student will have to undertake a research/development/ industrial product project for a period of 3 months and prepare a project report. The project work should take the form of either a report for the manufacture of a selected project, a dissertation on a practical problem in a leading polymer industry or a research problem. In the project report/dissertation, the student is expected to show appropriate ability in the organization and presentation of the material and sufficient mastery in all.

PE 1802 Industrial Training

Each student will have to undergo intensive practical training for a period of two months. After the training the student has to submit a detailed report on the training and give a presentation on it. Report and presentation will have equal weightage.