## M. TECH(POLYMER SCIENCE AND TECHNOLOGY)

<table>
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<tr>
<th>Course No</th>
<th>Subjects</th>
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<td><strong>1ST SEM</strong></td>
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<tr>
<td>TPT-1001</td>
<td>Polymer Material Technology – I</td>
<td>4</td>
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<td>TPT-1003</td>
<td>Polymer Processing Technology</td>
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<td>TPT-1005</td>
<td>Polymer Physics</td>
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<td>Breadth paper</td>
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<td>Elective – I</td>
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**Laboratories**

| TPT-1002  | Polymer Science Laboratory-I             | 0 | 0 | 3 | 2  |              |
| TPT-1004  | Polymer Processing Laboratory            | 0 | 0 | 3 | 2  |              |

**2ND SEM**

| TPT-2001  | Polymer Characterization and Testing     | 3 | 0 | 0 | 3  |              |
| TPT-2003  | Polymer Blends and Alloys                | 3 | 0 | 0 | 3  |              |
| TPT-2005  | Polymer Material Technology – II         | 4 | 0 | 0 | 4  |              |
|           | Breadth paper                            | 3 | 0 | 0 | 3  |              |
|           | Elective – II                            | 3 | 0 | 0 | 3  |              |

**Laboratories**

| TPT-2002  | Polymer Science Laboratory-II            | 0 | 0 | 3 | 2  |              |
| TPT-2004  | Polymer Technology Laboratory            | 0 | 0 | 3 | 2  |              |

**3RD SEM**

| TPT-3004  | Thesis (Part – I)                        | 0 | 0 | 0 | 15 |              |

**4TH SEM**

| TPT-3004  | Thesis (Part – II)                       | 0 | 0 | 0 | 20 |              |

| **Total** |                                         |   |   |   |    | 75  |
Elective-I [3-0-0]
TPT-1007 Advanced Polymer Chemistry
TPT-1009 Polymeric Biomaterial
TPT-1011 Polymerization Reactor Engineering
TPT-1013 Elastomer Technology
TPT-1015 Environment and Plastics
TPT-1017 Engineering Plastics
TPT-1019 Surface Coating and Paint Technology
TPT-1021 Principles of Polymer Technology (Compulsory for Students from Non-Polymer Background)

Elective-II [3-0-0]
TPT- 2007 Nanoscience and Technology
TPT- 2009 Polymer Composite
TPT- 2011 Computer aided Material Design
TPT- 2013 Membrane Science and Technology
TPT- 2015 Polymer Process Engineering
TPT- 2017 Electroactive Polymer
TPT- 2019 Fibre Science and Technology
SEMESTER-I

TPT-1001 Polymer Material Technology-I

Module 1: Relation-ship between polymer structure with chemical composition, molecular weight, flexibility, mechanical properties, thermal properties, electrical, optical, chemical, acoustic properties, chemical reactivity, aging and weathering, diffusion, permeability, toxicity, inter molecular & super-molecular structure, dielectric constant, power factor, transition in polymer system, glass transition, melting temperature, brittle temperature, cross linking & its effects, effect of polarity & rigid or flexible group on properties & application of polymer

Module 2: Molecular wt. & Molecular wt. distribution of polymer Determination of Molecular weight by viscometry, osmometry, light scattering, GPC, end group analysis & sedimentation method etc. Glass transition temp, Determination of glass transition temperature.


Module 6: Manufacturing process of Polyolefin: LDPE, HDPE, XLPE, UHMHDPE, chlorinated PE, LLDPE, PP-flow sheet & process alternatives, processing application, major engineering problems & economics, manufacturers in India, catalyst used.

Module 7: Manufacturing process of PS, PVC, PVOH, PTFE-flow sheet & process alternatives, processing application, major engineering problems & economics, manufacturers in India, catalyst used.

Books:

Module 2: Injection moulding process: Machine construction details, Shrinkage in injection moulding, Orientation arising in moulding, Injection moulding of thermosetting plastics. Troubleshooting in injection moulding. (10)

Module 3: Blow moulding: Extusion and Injection Blow moulding, Stretch blow moulding, Wall thickness and Parison thickness relationship, coextrusion blow moulding. (5)

Module 4: Thermoforming, Rotomoulding, (6)

Module 5: Compression moulding, Processing of polymer composites: Open and close mould process. Filament winding, Vacuum bag moulding, DMC, SMC, Reaction Injection moulding, Resin transfer moulding, Pultrusion. (5)

Module 6: Foams and foam processes: Foam processes, Expandable polystyrene foam, RIM foam moulding, Design guideline for integral foam. (5)

Module 7: Compounding, Mixing-dispersive and distributing. Dry blending, Principle of melt mixing, batch and continuous mixing process. (5)

Books:
4. Thermoforming, J.L.Throne, Hanser, 1987
TPT-1005 Polymer Physics


Module-3: Measurements of polymer sizes in solution: osmotic pressure, light scattering, intrinsic viscosity, size-exclusion chromatography. Polymer melts / concentrated solutions, SANS studies of chain dimensions and of correlation hole. Polyelectrolytes. (7)


Books:
1. Text Book of Physical Chemistry ; S. Glasstone, Mc millan and Co. 1962, New Delhi, 2nd Ed. 1962
ELECTIVE-I

TPT-1007 Advanced Polymer Chemistry

Module 1: Polymer Structure, nomenclature of chain growth & step growth polymer, Classification of Polymerization reaction, Initiator chemistry (Azo compound, peroxide, carbonate).  (5)

Module 2: Free radical chain growth polymerization process, kinetics of free radical polymerization. Metal alkyl initiator, photo chemical initiator, Initiation of polymerization with radio active sources & electron beams, Allylic polymerization, polymerization of complexes with Lewis acids, steric control in free radical polymerization. (7)

Module 3: Living polymerization, Atom transfer polymerization chemistry of Ionic chain growth polymerization Two and one electron transposition initiation reaction, pseudo cationic & Isomerisation polymerization. (6)

Module 4: Anionic polymerization of olefins, coordinated anionic polymerization, polymerization of aldehydes polymerization of ketones & Isocyanates, copolymerisation by ionic mechanism, olefinic metathesis, configurational statistics and propagation mechanism in chain growth polymerization (7)

Module 5: Chemistry and kinetics of ring opening polymerization, polymerization of oxirane, oxetanes, tetrahydrofuran, cyclic acetals, lactones, lactams. Spontaneous alternating zwitterions copolymerization. (7)

Module 6: Mechanism and kinetics of step growth polymerization, dendrimers and hyperbranched polymer, reaction in polymer (addition, rearrangement, substitution, elimination), block and graft copolymer (8)

Module 7: In-situ and solid state polymerization, classical and statistical thermodynamics, configuration and conformation of isolated polymer chain, thermodynamics of polymer solution and melt. (5)

Books:

Module 2: Structure-property relationship of polymeric (Natural-protein, polysaccharides etc and synthetic-polylefins, Acrylics, celluloses epoxy, Fluoro polymers, Vinyl polymers, polyurethanes, silicones, hydrogels etc.), and non-polymeric (Metals, ceramics, and composites) Biomaterials. Structure property relationship of mineralized and non mineralized tissues (bone, teeth, skin, ligament, tendon, cartilage etc.) (10)

Module 3: Bio compatibility and blood compatibility, Bio-ethics. Invitro and invivo test for biocompatibility and blood compatibility. Modification to enhance biocompatibility - Copolymerization, blending, surface treatments (Coating, heparinization, grafting etc). (6)

Module 4: Bioactive, Bioresorbable, Biodegradable, Superabsorbent, Biostable and porous tissue ingrowth implant materials. Sterilization of implants. Deterioration of polymer properties. (4)

Module 5: Soft tissue replacement - Extra corporeal, intracorporeal devices, sutures, surgical tapes, adhesives, percutanious devices, heart assist device, artificial skin, maxillofacial organs, kidney, eye. (8)

Module 6: Hard tissue replacement - various joints, fracture fixation devices, dental implants. Bone implant fixation problems and steps to mitigate them. (6)

Module 7: Drug delivery system, Polymeric medication, Disposable in Health care, Packaging. (6)

Books:
TPT-1011 Polymerization Reactor Engineering

Module 1: Engineering Principles applied to the analysis and design of Polymerization process. Kinetic analysis and molecular weight distribution of linear polymerization processes (Condensation and addition polymerization). Kinetic analysis and molecular weight distribution of non-linear polymerization processes (Condensation and addition polymerization) (5)

Module 2: Copolymerization kinetics, copolymer molecular weight distribution (MWD), copolymer composition distribution (CCD) & copolymer sequence distribution (CSD) (6)

Module 3: Polymerization techniques: mass, solution, suspension and emulsion. Particle size distribution (suspension and emulsion polymerization) (6)

Module 4: Ideal polymerization reactors: Batch & semi batch reactor, CSTR and PFR. Molecular weight distributions (qualitative and quantitative analysis) in CSTR and PER for addition and condensation polymerization (8)

Module 5: Heat and mass transfer, reactor dynamics, reactor stability, flow around agitator and mixing effects on polymerization. (5)

Module 6: Optimization of polymerization reactors: poly(methylmethacrylate), poly(vinyl chloride), poly(ethylene terephthalate) and Nylon 6 (using Pontrygon maximum principle and Genetic Algorithm) (5)

Module 7: Case studies of industrial polymerization reactors: poly(vinyl chloride), polystyrene, poly(ethylene terephthalate), Nylon 6 and Nylon 66. (5)

Books:
Module 1: History and growth of rubber technology, general consideration of diene polymers, natural and synthetic rubber lattices, composition, stability, gelation, preparation of dry rubber from natural rubber latex, types and grades of rubber. Physics of raw vulcanised rubber – Entangled rubber elasticity, linear viscoelasticity of rubber (6)

Module 2: Natural rubber - Chemical structure, auto oxidation and other reactions, blending with other polymers, compounding, vulcanisation. (5)

Module 3: Chemistry and technology of synthetic rubbers -poly isoprene, SBR, nitrile, polybutadiene, polychloroprene, EVA, EPDM, Butyl rubber, poly sulfide rubbers, chlorosulfonated polyethylene, silicone rubber, thermoplastic elastomers. (10)

Module 4: Rubber compounding and vulcanization principle and mechanism, Mastication, mixing and compounding. Additives - fillers, accelerators, activators, antioxidants, antiozonants, sulfur etc. Theory and technology of reinforcement. (6)

Module 5: Use of textiles as reinforcing materials. Mechanism and practice of sulfur vulcanization and nonsulfur, vulcanization (peroxide, metaloxides and other special curing systems). (6)

Module 6: Rubber Processing Machineries - Mills, Mixers, Extruders, Calendars, Compression, Injection moulding. (5)


Books:

TPT-1015 Environment and Plastics


**Module 2:** Pretreatment of polymer waste: Classification, washing drying, size reduction, special cleaning techniques, sorting techniques. Mechanical Recycling: Filtration system. Additives blends technology in recycling problem encountered in extrusion, extrusion blow moulding, injection moulding of recyclates. Press processing of homogeneous recyclates. (8)

**Module 3:** Commercial recycling plants. Machineries for plastic recycling. Properties and application of recyclates PE, PP, PS EPS, PVC, PET, Polyamides Polyurethanes, FRP, Commingled plastics waste. (8)

**Module 4:** Feed stock recycling: Degradative Extrusion, Pyrolytic techniques, Hydrogenation, Gasification, Reduction in Blast Furnace, Depolymerization of polyamides, PMMA, solvolytical process for PET, Polyamides, polyoxymethylene. (5)

**Module 5:** Energy recovery from plastic waste in waste incineration plant. Waste Rubber Recycling. (8)

**Module 6:** Pollution control in petroleum Refining and petrochemical Industries. (4)

**Module 7:** Toxicity of plastics: Commodity plastics, toxicity of additives used in plastics. Industrial hygiene, Toxicity due to plastics combustion, rules and regulation of plastic toxicity. (4)

**Books:**
2. Polymer Recycling, Jhon Scheirs, John Wiley and Sons, 1998
TPT-1017 Engineering Plastics

**Module 1:** Polyamides - aliphatic polyamides-nylon 6, nylon 11, nylon 7, nylon 46, 66, 69, 610, 612 - structure and properties of aliphatic polyamides, additives, processing, application, commercial grades, modified nylons Polyimides-modified polyimides-polyamide-imides-polyetherimides-elastomeric polyimides

**Module 2:** Polycetals- Synthesis of acetal resins, structure and properties, processing, additives-acetal-alloys-application of homo and copolymers-elastomeric acetals-Oxetane polymers

**Module 3:** Polysulfones, polyphenylene sulfides-PPS, PPSO - structure and properties, processing, application and blends with other polymers

**Module 4:** Poly phenylene oxides, polyetherketones- PPO , PEK, PEEK- structure and properties, processing, application and copolymers, blends

**Module 5:** Polyesters- Unsaturated Polyesters-curing system, production, commercial grades, structure and properties, water extended polyesters, fibre reinforced composites, moulding compositions and processing, fibre and film forming polyesters PET, PBT and copolyesters-liquid crystalline polyesters-application

**Module 6:** Polymers for high temperature resistance-Flourine containing polymers, inorganic polymers, poly p-phenylene, ladder and spiro polymers, coordination polymers

**Module 7:** Polycarbonates-synthesis through ester exchange-structure and property relation, commercial grades-processing characteristics-application of polycarbonate alloys and homo-polymers-commercial copolymers

**Books:**

1. Plastics Materials: Brydson J.A., ih Edn., Butter worth,
**TPT-1019  Surface Coating and Paints Technology**

**Module 1:** Introduction. Types of surface coatings- Lacquer, Paint, Varnish, Enamel. Film forming coating materials: Reactive polymers, Non-reactive polymers.  
(5)

(5)

**Module 3:** Additives for paints: Fundamentals, Anti corrosive, Pigment enhances, Anti foams, Anti settling agents, Anti skinning agents, Container corrosion inhibitors, Anti gassing additives, Dispersion aids, Driers.  
(6)

**Module 4:** Theory of coating materials: Immersion and wetting of the pigment, Deagglomeration, Dispersion, stabilization, Depletion flocculation, Rate of flocculation, Adsorption. Particle size and its distribution.  
(8)

(7)

**Module 6:** Characterisation of coating, structural, surface properties and morphological properties of coating, Mechanical properties of surface coatings: Hardness test, Flexibility test, Impact test, Bend test, Scratch test, Adhesion, Accelerated weathering, Chemical resistance test. Quality control of finished product: Fundamentals, Quality control tests (Gloss, Opacity, Colour etc.).  
(7)

**Module 7:** Industrial Coatings: Formulation and methodology (Appliance finishes, automotive finishes, Coil coatings, Can coatings, Marine coatings, Air-craft finishes, Building coatings, Paper coatings).  
(7)

**Books:**
**TPT-1021 Principles of Polymer Technology**

**Module 1:** Introduction & historical background, Macromolecular concept, structural facture of polymer, Classification of polymer, Functionality principle (6)

**Module 2:** Types of polymerization, General theory of addition & condensation polymerization. Kinetics of chain & step growth polymerization, photo initiation, Radiation polymerization, concept of copolymerisation, Ionic & Coordination polymerization, Stereo regular polymerization, Living polymer, (8)

**Module 3:** Determination of molecular reactivity, ratio, Q-e scheme, Block & graft copolymerisation (5)

**Module 4:** Mol: wt & Mol: wt; distribution of polymer Determination of Molecular weight by viscometry, osmometry, light scattering, GPC, end group analysis & sedimentation method. (5)

**Module 5:** Glass transition temp, Determination of glass transition, brittle temperature, melting temperature. (3)

**Module 6:** Synthesis, Properties and application of Polyethylene, Polystyrene, Polypropylene, PVC, PMMA, Polyester, UF, PF. (7)

**Module 7:** Special application of polymers: conductive, magnetic, optical, photoresponsive polymers (6)

**Books:**

SEMESTER-II

TPT-2001 Polymer Characterisation

Module 1:- Mechanical properties of polymers: Principle tests for mechanical properties (tension, shear, compression, flexural, hardness, impact, abrasion, creep, stress relaxation). (6)

Module 2:- Electrical properties (receptivity, dielectric strength, permitivity, power factor etc), optical properties (gloss, clarity), Chemical properties (solubility, flammability, LOI, vicat softening point & HDT, permeability, ageing & weathering, ESC, adhesion) flow properties (MFI, viscosity). Determination of Magnetic, Optical (Birefringence & photoelasticity), Nonlinear Optical properties and Acoustic Properties. (7)


Module 5:- Xray Diffraction Methods : Classification of Crystal systems, Symmetry elements, point Group and Space Group, Principle of X Ray Scattering and Diffraction, Interplaner Spacing Bragg's Law and Laue Conditions. Instrumentation, Application of WAXS and SAXS in polymer characterization- degree of Crystallinity (Ruland's method), Crystallite size analysis, Orientation (Pole Figures), residual stress. X-ray fluorescence Spectroscopy, Application for determination of crystallinity, and residual stresses. (7)

Module 6:- Thermal analysis: Principle, Instrument, and application - Differential Scanning Calorimetry(DSC), Differential thermal analysis(DTA), Thermogravimetric analysis (TGA), Dynamic mechanical thermal analysis (DMTA). (7)

Module 7:-Chromatography: Principles and Applications of High Performance Liquid Chromatography and High Performance Thin Layer Chromatography, Pyrolysis Gas Chromatography (5)

Books:
TPT-2003 Polymer Blends and Alloys

**Module 1:** Definition & classification of polymer blends & alloys. Physical, Mechanical & thermal properties and testing of polymer blends. (7)

**Module 2:** Thermodynamic theory - thermodynamics of polymer mixing, Rheology of blends. (7)

**Module 3:** Experimental determination of miscibility of blends- turbidity, light scattering, SAXS, WAXD, SANS, Fluorescence, ultrasound etc. (6)

**Module 4:** Structure properties relationship of multi phase system. Compatibilisation - Reactive & physical compatibilisation. (6)

**Module 5:** Blends morphology & characterization-Optical microscope, SEM, TEM, AFM. (6)

**Module 6:** Techniques of blending, Commercial blends & applications. (6)

**Module 7:** Toughened polymers, Liquid Crystalline Polymers, Interpenetrating polymers, High performance Engineering polymer blends. (7)

**Books:**
Module 1: Properties, Processing, Application and Manufacturing process, Major engineering problems, Economics and Indian scenario of the thermosets: Phenolic resins, aminoplasts, (6)

Module 2: Alkyl, & aryl epoxies, polyurethanes, silicones and polyester (5)

Module 3: Acrylics, polyvinyl ester, cumarene resin, indene resin, silicon resin. (5)

Module 4: Copolymers –EVA, EPDM, ABS, SAN, ethylene – ethylacrylate ionomers, (6)

Module 5: Engineering plastics: Polyamides: nylon 66, nylon 6, nylon 11, nylon 12, polyimides. (10)

Module 6: High performance thermoplastics: Polyacetal, Polycarbonate, (5)


Books:
ELECTIVE-II

TPT-2007 Nanoscience and Technology

Module 1: Introduction to nano world: Nano terminology and definition Classification scheme for nanomaterials: Top-down versus bottom – up manufacturing. Structure and properties of fullerenes, carbon nanotubes, metal and polymer nanoparticles. (5)

Module 2: Novel Physics and Chemistry of Nanodimension: unique chemical, electronic, magnetic, optical, thermal and mechanical properties. (5)


Module 4: Self-assembly of nano particles and nano structural molecular materials, Principle of molecular self assembly and self organization, surfactant solutions, Polymers, biological system and liquid crystals. (6)

Module 5: Self assembled monolayers, thiol and silane monolayers. Langmuir-Blodgett films, topological substrate patterning, DNA directed self assembly. (6)

Module 6: Properties and problems of inorganic/organic interfaces, Polymer surfaces and interfaces structure and properties. (6)

Module 7: Interaction of biological molecules with surfaces: manipulation of biomolecules on surfaces: transduction and control of materials and information through biological interfaces: bilayers, bioelectronic nano hybrid and biosensors. (7)

Books:
2. Introduction to Nanotechnology by Charles P. Poole and Frank J. Owens John Wiley Interscience 2003
TPT-2009 Polymer Composite

**Module 1:** Composite material for structural application. Resins for FRP polyesters, epoxy, vinyl ester, phenol formaldehyde, urea formaldehyde, polyimide, furfural based resins, Furan resins etc.

**Module 2:** Thermoplastic composites matrix - PEEK, PP, PEK, PBT PC, ABS, Nylon etc. Reinforcing fibres - glass, aramid, carbon, boron etc.

**Module 3:** Surface treatments of reinforcing fillers. Particulates reinforcement. The behaviour of constituents material/metal, polymer, ceramic. Performance of short and long fibre composites, Nano composites.


**Module 5:** Design concept, product management and quality control. Environmental effects & the effects of defects on the performance of composites. Testing and joining of composite materials.

**Module 6:** Manufacturing Techniques of Composites: Filament winding, Pultrusion, Vacuum bag, Pressure bag, Had lay up, Spray up, Compression moulding, Injection moulding

**Module 7:** Polymer foams, - Manufacture, structure property relationship.

**Books:**
Module 1: Introduction: Computational Chemistry and Molecular Modeling, Coordinate systems, Concept of 2D and 3D structure, Molecular energetic profile, 3D-Structure file, Structural Data Bases, Structural properties, Potential Energy Surfaces, Forcefields, Molecular and Mesoscale model of polymers, Simulation methods. (5)

Module 2: Quantum Mechanics, Molecular Orbital calculations, Hatree-Fock Equations, Semi-emperical methods, Huckel Theory, Ab-initio calculations, Valence Bond Theories, Energy Component Analysis. (8)

Module 3: Empirical Forcefield Models: General features of Molecular Mechanics, Geometrical Parameters: Bonded Parameters, Non-bonded Parameters (Electrostatic interactions, van der Waals interaction, Hydrogen bonding), Hydrophobic interactions, Hydrogen bonding in molecular mechanics, Calculating thermodynamic properties using a forcefield for different materials, Force field Parameterisation. (10)


Module 5: Computational Simulation Methods: Thermodynamic Properties, Phase space, Boundaries and Equilibration. Molecular Dynamics simulations, Monte Carlo Simulation Methods. (9)

Module 6: Use of Discover, Amorphous cell, Mesodyn, Dissipiative Particle Dynamics for the modeling of i) Diffusivity, ii) Mechanical properties, iii) Morphology and iv) Electrical properties (3)

Module 7: Predicting and describing polymer behavior using range of tools
i) Correlation Methods: Quantitative Structure Property Relationship methods (QSPR), ii) Statistical mechanics and iii) Coarsed grained models (4)

Books:


2. Computational Modelling of Polymers, ed J.Bicerano, MerceL Dekker Inc. 1992
TPT-2013 Membrane Science and Technology

Module-1: Synthetic membranes and their preparation: Forces in Membrane Separation Processes, Methods of Their Preparation, Neutral and Asymmetric Microporous Membranes, Preparation Procedures of Asymmetric Membranes, The Formation Mechanism of Microporous Symmetric or Homogeneous Polymer Metal, Glass, Liquid, Ion-Exchange and Composite Membranes, Preparation Procedures of Composite Membranes, Industrial Scale Membrane Production, Membrane Modules and Their Fabrication, Membrane Manufacturing Equipment. (6)


Module-3 Reverse osmosis: Basic Process Considerations Reverse Osmosis Membranes, Membrane Packaging, Plant Design, Industrial Reverse Osmosis at a Refinery and Ion Exchange, Seawater Desalination, Cellulose Acetate Membranes, Microporous Polysulfone Supports for Composite Membranes, Interfacial Polymerization with Monomeric Amines, Mechanism of Interfacial Membrane, Formation of Sulfonated Polymer Composites, Plasma Polymerization in Composite Membrane Fabrication (7)


Module-5: Enzyme Gel Layer Reactors, Membrane Segregated Enzyme Reactors, Membrane Bound Enzymes in Continuous-Flow Systems, Membrane Fermentors. ELECTRODIALYSIS: Ion-Exchange Membranes, Applications of ED, Bipolar Membranes, Electrodes and Stack Power, Concentration Polarization, Membrane Fouling. (6)


3. Nano and Microengineered Membrane Technology: CJM, Van Riju
TPT-2015 Polymer Process Engineering


Module 5: Modelling for Fibre spinning, film blowing, film casting and stretching  

Module 6: Profile extrusion, calendaring, fibre spining  


Books:
2. Polymer Extrusion: Chris Rauwendaal, Hanser, 4th Edn.
# TPT- 2017 Electroactive Polymer

**Module-1:** Introduction: Photochromism, Electrochromism, Conductive Crystal, liquid crystal.  
(5)

**Module-2:** Conductive Polymers: Conjugated Conductive Polymers, chemical and electrochemical synthesis, structure and properties (polyacetylene, polyphenylvinylene, polypyrrole, polyaniline, polythiophene)  
(8)

**Module-3:** Polymer Dopant Interaction: Diffusion of dopants, Chemistry of Doping (Iodine and other halogens, Arsenic and antimony halides, Metal halides)  
(7)

**Module-4:** Protonic acids and covalent dopings. Other p-type dopants, n-type dopants, compensation effects, Solvation effects. Doping levels, Lattice packing and morphology, Charge transfer from polymer chain to dopant.  
(5)

**Module-5:** Ion conducting materials: synthesis, characterization and structure properties of sulfonated polystyrene, polyary ketone, polyary sulfone, polybenzimidazole. Characterisation: IEC, Dielectric, Impedence spectroscopy, cyclic voltmeter.  
(7)

(5)

**Module-7:** Applications of polymers in electronic devices: MEMS, Polymer batteries, Fuel cell, Sensors and sensor arrays.  
(8)

**Books:**  
1. Electrical and Optical Polymer Systems.  
   Donald Lewise, Gary Wnek, Debra Trantolo, Thomas Copper, Joseph Gresser.  
   Marcel Decker Inc. 1998  
2. Molecular Electronics – Geoffrey Ashwell  
   Person Studies Press Ltd. 1992  
3. Functional Monomers and Polymers  
   Kiichi Takemoto, Raphael Ottenbrik, Mikiharu Kamachi  
   Marcel Dekker Inc. 1997
Module-1: Natural fibre - Cotton, linen, jute, hemp, sisal, coir, wool, silk, asbestos etc, chemical structures, source, use and limitations. Quest for synthetic fibres. (10)

Module-2: Conventional man made fibres: Rayon, Polyethylene terephthalate, Nylon 6 and nylon 66, Acrylics, Polyolefins, Polyvinyl Chloride, Polyvinyl Alcohol, Elastomeric. (3)


Module-5: Characterization of fibres - Fibre Morphology, Dye uptake, Thermal properties, Chemical stability, Fineness-Denier & Tex, crimping properties, length, twists and intermingling. (8)

Module-6: Mechanical Properties, Electrical properties, Shrinkage, uniformity, Frictional properties, Tensile and optical properties. (3)

Module-7: Brief outline of manufacture of textiles: Fibres to yarn, Yarns to Fabrics-weaving, knitting, braiding, Compound fabric constructions, Finishing processes, Dyeing and printing. (3)

Books:  
Breadth Paper (3-0-0) (for PG Courses of other departments)

1st Semester
TPT- 1023 Basic Polymer Engineering
TPT-1025 Rubber Product Technology
TPT-1009 Polymeric Biomaterial
TPT-1015 Environment and Plastics

2nd Semester
TPT-2023 Plastics Product Design & Rapid Prototyping
TPT-2025 Computer Aided Engineering & Design
TPT- 2007 Nanoscience and Technology
TPT-2009 Polymer Composite