Proposed Syllabus Structure for the B.Tech Course, Polymer Engineering and Technology Department

**Semester I**

<table>
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<tr>
<th>No.</th>
<th>Subjects</th>
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<td>Material &amp; Energy Balance Calculations</td>
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- #where there are one special subject or practical in specials bracket it should be considered common for both Polymer & Paints students
- * where there are two special subject or practical in specials bracket first one is for Polymers & second one is for Paints students
### Semester III

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**TOTAL**  | 18  | 300  | 18 |

| 7   | PSP 1P11    | Pr 10: Analysis & Characterization of Polymers | 8  | 100  | 4 |
| 8   | PSP 1P12    | Seminar                                       | 4  | 50   | 2 |
| 9   | PST 1C20    | Pr 11: Processing of Polymers-I I             | 4  | 50   | 2 |

**Total Practicals**  | 16  | 200  | 8  |

**TOTAL**  | 34  | 500  | 26 |

### Semester VIII

<table>
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<td>Value Education</td>
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<td>Design and Analysis of Experiments</td>
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**TOTAL**  | 18  | 300  | 18 |

| 7   | PSP 1P16 Spl 12: Processing of Polymers-I I   | 4  | 50   | 4 |
| 8   | PSP 1C21 Experimental Project                 | 12 | 150  | 6 |

**Total**  | 34  | 500  | 28 |

Total credits of all semesters = 25 (Sem I) + 26 (Sem II) + 25 (Sem III) + 24 (Sem IV) + 26 (Sem V) + 27 (Sem VI) + 2 (IPT) + 27 (Sem VII) + 28 (Sem VIII) = 209

Total Marks: 600 (Sem I) + 600 (Sem II) + 550 (Sem III) + 550 (Sem IV) + 500 (Sem V) + 550 (Sem VI) + 50 (IPT) + 500 (Sem VII) + 550 (Sem VIII) = 4450

- #where there are one special subject or practical in specials bracket it should be considered common for both Polymer & Paints students
- * where there are two special subject or practical in specials bracket first one is for Polymers & second one is for Paints students
<table>
<thead>
<tr>
<th>Subject heads</th>
<th>AICTE Norms</th>
<th>Proposed syllabus in %</th>
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<tr>
<td>General</td>
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<td>Basic Sciences</td>
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<td>General Engineering +Chemical</td>
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<td>Engineering</td>
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Electives to be offered by Polymer Engineering and Technology Department and their prerequisite

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<tr>
<th>S. No.</th>
<th>Elective</th>
<th>Prerequisite</th>
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<tr>
<td>1</td>
<td>Polymer Science &amp; Technology II(SemIII)</td>
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<td>Polymer Science &amp; Technology III (SemIV)</td>
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<td>Elective II: Packaging &amp; Decoration of plastics (Sem. VII)</td>
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<td>4</td>
<td>Elective III-Advanced Polymer Science &amp; Technology (Sem VIII)</td>
<td>Polymer / Paints / Textiles Background</td>
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SEMESTER I
No Special Subjects

SEMESTER II
No Special Subjects

SEMESTER III

THEORY

PST1C01 Special 1: Polymer Science & Technology I
(Polymer/ Surface coating) (4 h/ week) Marks 100

Historical developments in polymeric materials, Basic concepts & definitions: monomer & functionality, oligomer, polymer, repeating units, degree of polymerization, molecular weight & molecular weight distribution. (5)

Natural Polymers: Chemical & Physical structure, properties, source, important chemical modifications, applications of polymers such as cellulose, lignin, starch, rosin, shellac, latexes, vegetable oils and gums, proteins etc. (9)

Raw material for synthetic polymers: Manufacturing of various fractions of crude petroleum important for polymer industry for (a) Raw Materials such as ethylene, propylene, butadiene, vinyl chloride, vinylidene dichloride, styrene, acrylic monomers like acrylic acid, acrylonitrile, methacrylic acid, methacrylates, acrylamide etc, (b) solvents such as alcohols, toluene, xylene, acetone, ketones, terpenes, chloromethanes etc. Evaluation of raw materials and reactants for synthesis & manufacturing of polymers. (c) Polyacids such as phthalic acid, terephthalic acid, isomers and anhydrides etc. (d) phenols, polyols and their modifications, (e) Isocyanates, (f) Amino Compounds, (g) Other petroleum based material (31)

(15)

Textbooks/Sourcebooks:

PST1C02 Special 2 Polymer Science & Technology II
(Polymer/ Surface coating) (2 hrs/ week) Marks 5

Classification of polymers thermoplastic/ thermoset, addition/ condensation, natural /synthetic, crystalline/amorphous, step growth /chain growth, commodity…specialty, homochain/
heterochain, confirmation: homo & copolymers (detailed graft ,block alt, ladder etc. &
nomenclature), configuration cis/trans; tacticity, branched/ crosslinked, Classification of
polymers based on end use etc. (7)

Molecular weight and its distribution determination (Mn to Mz & MWD), carothers equation,
states of polymers, transition temperatures such as Tg, Tc, Tm, solubility parameter, solution
properties, temperature, good/ bad solvent, (12)

Addition, condensation polymerization mechanism (7)

Surface tension/ energy & contact angle measurements of different polymeric systems & their
wetability with other substances. (4)

Textbooks/Sourcebooks:
2. Polymer Science , Gowarikar, Johan wiley and Sons 1986.
8. Introduction to Polymer Science and Technology, H. S. Kaufman and J. J. Falcetta,
    Wiley – Interscience Publication, 1977
9. Polymer Science and Technology of Plastics and Rubbers, P. Ghosh,
12. Fundamentals of Polymer Science an introductory text, P. Painter and M. Colman,
16. Fundamentals of Polymer Processing, S. Middleman, Houghton Mifflin Compony,
    1997.

PST1C03: Spl 3: Materials Technology: (2 hrs/ week)
(Polymer/ Surface coating) Marks 50

Crystal structure, crystal defects, atomic packing factor, study of different metals iron/steel, Al,
brass, copper, nickel, chrom, titanium etc. Their different grades/ compositions of alloys.
Annealing, nitriding, carburizing & other treatments etc. corrosion of metals, electrochemistry,
corrosion & its prevention. Use of different grades of steel for manufacture of reactors, molds,
dies & plastic processing equipments.

Textbooks/Sourcebooks:
               Mechanical metullargy       Dieter
Practicles:

PSP1C04:Pr1: Analysis & Characterization of raw materials & polymers-IV (Polymer/ Surface coating) Marks 50

1) To Check the colour of oil & resins.
2) To Check the colour of oils & resins on heating.
3) To check the viscosity of oils & resins solution using Ford Cup or Brookfield viscometer.
4) To check the melting range of given resin by capillary tube method.
5) To find the acid value of given sample.
6) To find Aniline point of given solvent.
7) To find the distillation large of given solvent.
8) To find the evaporation rate of given solvent.
9) To find flash point of given solvent.
10) To find moisture content of solvent (qualitative analysis)
11) To find specific gravity of solvent by pycnometer.
12) To find the moisture content of pigment.
13) To find the water soluble matter of pigment.
14) To check the Acidly & Alkalinity of pigment.
15) To check bleeding of pigment.
16) To find oil absorption value of pigment.
17) To find minimum surfactant demand by Daniel flow-point method

SEMESTER IV

THEORY

PST1C05: Spl 4: Polymer Science & Technology III (Polymer) (Polymer/ Surface coating) Marks 100

Techniques of polymerization: bulk, solution, suspension, emulsion, plasma etc. Different initiating systems such as free radicle polymerization, redox, cationic & anionic polymerization (different terms such as living polymers, inifers, telechelics). Their kinetics & control over structure of polymer. (18)

Condensation polymerization, different catalysts used case studies of condensation polymerization, carothers equation, Comparison of these systems with advantages & disadvantages. (10)

Copolymerization, reactivity ratios & kinetics of copolymerization (copolymer composition equation). (10)

Rheological concepts of polymer solutions and melts, degradation plasticization Mixing operations: Typical agitation system, dissolution (10)

Different advanced catalyst systems: Ziegglar natta catalyst & metallocene catlystis & their role in polyolefins, ATRP etc. (12)

Textbooks/Sourcebooks:
2. Polymer Science, Gowarikar, Johan wiley and Sons 1986.
9. Polymer Science and Technology of Plastics and Rubbers, P. Ghosh,

PST1C06:Spl 5: Thermoplastic Polymer Technology I
(Polymer/ Surface coating) (2 hrs/week) Marks 50

Polyethylenes; modified polyethylenes, Polypropylene and copolymer of PP, modified Polyolefins like crosslinked & filled polyolefins, Polyisobutylene & polyolefin plastomers etc. (15)

Engineering Polymers Polyesters such as PET, PBT, PTT, Polycarbonates, Polyacetal etc. (15)

PST1C07: Spl 6: Technology of Thermoset Resins-I
(Polymer/ Surface coating) (2 hrs/ week) Marks 50

Polyester Resins- unsaturated polyesters resins: Raw material: poly-basic acids, polyfunctional glycals. Curing of resins through unsaturation of the resin/polymer backbone. Curing systems, catalysts and accelerators. Polyester based composites & their recipes, Water reducible polyesters, high solid polyesters/ polyesters for powder coatings Moulding compositions, DMC,SMC,fibre and film forming compositions. (12)

Phenolics: Basic components of the polymer. Different kinds of phenols and their derivatives, different kinds of aldehydes used. Novolacs and Resol: effect of the ratio of phenol to aldehyde on the nature and the property of the polymer.Theory of resinification and effect of pH on the reaction mechanism and the reaction product. Curing of phenolics Modification of phenolics such as novolac-epoxy oil soluble and oil reactive. Phenolic moulding compounds, ingredients, compounding and applications. (9)

Amino resins: Basic raw materials used like urea/melamine/ aniline/ formaldehyde. Synthesis of UF and MF resins.Theory of resinification and effect of pH on the reaction mechanism and the reaction product. Properties and application of the UF, MF and AF resins Modification of
resins with alcohols and phenols Moulding materials, compounding, processing and applications. (9)

Text/ Source Books

19. Polymer Technology by Miles and Briston
20. Surface Coating, OCCA Publication.
22. Organic Coating: Science and Technology by Z. Wicks.]

PST1C08:Spl 7: Colour Physics and Colour Harmony (Polymer/ Surface coating) (2 hrs/week) Marks 50

Introduction-geometric and chromatic attributes; Radiation and illumination; SPD, CT and CCT; Sources and illuminants; Need for artificial sources – various ways of producing light and different artificial sources; Lamp efficacy and colour rendering properties of sources. (6)

Interaction of radiation with matter – gloss and diffused reflectance, absorption of light in sample; Various transitions in molecule, Beer – Lambert law and its verification, deviation from Beer – Lambert law, Additivity of absorbance, mixture analysis, absorbance and scattering in the sample – Kubelka – Munk theory. (8)

Perception of colour in eye \brain, various colour theories (3)

Additive – subtractive mixing, colour specification systems – Munsell colour order system, CIE system, colour spaces, colour difference formulae. (6)
Single constant Kubelka – Munk theory of colourant formulation and recepie prediction; Modern computerised methods of colour matching; Finding the dyeing recipes, shade sorting, etc. using the CCM software

Decorative effect using pattern and design theory; Application of CAD for textiles.

Text/Reference Books:

PRACTICLES

PSP1C09: Pr 2: Analysis & Characterization of raw materials & polymers-II (Polymer/ Surface coating) (2 hrs/ week) Marks 50
1. To find polymer content and NVM of emulsion polymer
2. Analysis of carbon black, saw dust etc.
3. To find bulk density of fillers like TiO2, Carbon black etc
4. Identification of pigment by spot test
5. To determine Acid value, amine value, iodine value

PSP1C10:Pr 3: Synthesis & Characterization of resins & polymers-I (Polymer/ Surface coating) (2 hrs/ week) Marks 50
1) To synthesis polymer using Bulk, solution, suspension & emulsion polymerization method.
2) To study auto acceleration by solution polymerization method.
3) Synthesis of copolymers by emulsion Bulk, solution & suspension and emulsion, Polymerization.

PSP1C11:Pr4: Color Physics (Polymers) (Term Work) (Polymer/ Surface coating) (4hrs/week) Marks 50
1. Determination of unknown concentration of a dye in solution by Dubosque colorimeter.
2. Verification of B-L law (dependence of absorbance on concentration) by spectrophotometer.
3. Mixture analysis using spectrophotometer.
4. Determination of gloss of various samples using gloss meter
5. Determination of color of various textile samples in terms of Lovibond primaries and chromaticity co-ordinates using Lovibond tintometer
7. Finding color differences (ΔE) between set of samples vis a vis dye solution concentration.
8. Finding color differences (ΔE) between set of samples vis a vis time of exposure.
9. Determination of colors of samples in terms of Munsell color system using Munsell Color Tree.
10. Recipe prediction and matching of colored samples using CCM.

Suitable number of experiments from the above list will be performed

**SEMESTER V**

**THEORY**

**PST1C12: Spl 8: Thermoplastic Polymer Technology (Polymer) II**

*(Polymer/Surface coating)*

Styrenic polymers - Polystyrene, HIPS, SAN, ABS, important copolymers of styrene maleic anhydride and styrene acrylics copolymers, toughening mechanism of impact modified plastics.

Polymamides- Nylon 6, Nylon 6,6, Nylon 11, aromatic polyamide such as Kevlar

Acrylic polymers & copolymers, Polyacrylamide, PMMA, ASA, Polyacrylonitrile etc.

**PST1C13: Spl 9: Thermoplastic Polymer Technology (Polymer) III**

*(Polymer/Surface coating)*

Polyvinyl chloride & its copolymers, Polyvinyl acetate, Polyvinyl alcohol etc.

Modified cellulosics: Cellulose esters and ethers such as Ethyl cellulose, CMC, HPMC, cellulose acetals etc., Liquid crystalline polymers; speciality plastics- PES, PAES, PEEK, PEAK etc.

Developments in new polymers such as dendrimers, biopolymers & biodegradable polymers, thermoplastic PU etc.

**PST1C14: Spl 10: Technology of Thermoset Resins-II (Polymer)**

*(Polymer/Surface coating)*

Epoxy resins: Basic raw materials like epichlorohydrin and di hydroxy phenol. Different di hydroxy phenolic compounds which can be used. Classification of epoxy resins. Synthesis of epoxy resins. Ratios of reaction components and their effect on the properties of reaction product and molecular weight in particular. Curing of the resin: curing agents like amines, acids, anhydrides, etc. Epoxy compositions and their ingredients, like diluents, flexibilizers, etc. Epoxy adhesives along with their recipes. Novolac epoxy, epoxy acrylates, Modified epoxides & epoxy resins for advanced applications.

Polyurethanes- Thermoset: Basic components: diisocyanates and diols, different diisocyanates and diols used.Reactions of isocyanates with various other functional groups Synthesis of polymers Polyurethane foams, polyester and polyether foams. Processes like one-shot process,
Polyether pre-polymers, Quasi-pre-polymer polyether foams, etc. Difference between thermoset & thermoplastic PU. Flexible foams Polyurethanes in Coatings Polyisocyanates IPN using polyurethanes-acrylic blends (10)

Silicones Thermoplastic and Thermoset: Preparation of intermediates, Grignard’s method, direct method, olefin addition method, sodium condensation method, rearrangement of organo chlorosilanes. Nature and effect of Si-H, Si-O, Si-Si, and Si-C bond. Effect of different functional groups on properties, Silicone fluids, resins, elastomers, RTV silicones. Their compounding, processing and applications. Silicone modified resins. (8)

PST1C15: Spl 11: Technology of Thermoset Resins-III (Polymer) 
(Polymer/ Surface coating) 
(2 hrs/ week) 
Marks 50

Thermosetting acrylics: Synthesis of acrylic polymers and co-polymers, different techniques. Structure property relationship application of thermosetting acrylics, like anaerobic adhesives, laminating resins, etc. (6)

Alkyd resins: Basic components like polyfunctional alcohols, poly-basic acids, vegetable oils/fatty acids. Different types of drying oils: drying, semi-drying and non-drying with examples. Influence of all these components in the synthesis and properties of the final alkyds obtained modification of alkyds: modification with rosin, maleic anhydride, acrylics, vinyls, imides etc. (15)

Miscellaneous thermosetting polymers: Polyimides, plasma-polymers & other thermoset polymers (9)

Text/ Source Books
2) Encyclopedia of Polymer Science and Technology, Johan Wiley and Sons, Inc 1965.
12) Biopolymers, Wiley, VCH Verlag, 2003
19) Polymer Technology by Miles and Briston
20) Surface Coating, OCCA Publication.
22) Organic Coating: Science and Technology by Z. Wicks.

**PRACTICES**

**PSP1C16: Pr 5 : Analysis, Characterization of raw materials & Synthesis of resins & Polymers**
*(Polymer/ Surface coating)*

(2x2 hrs/ week) Marks 50

1.) Analysis of formalin, phenol, substituted phenol, epichlorohydrine, plasticizer..
2) Determination of Hydroxy value, K-Value, carboxyl value, epoxy value, ester value, sap value etc. RI of solvent and plasticizer, color and viscosity by Gardeners tube etc.

**PSP1C17: Pr 6 : Synthesis & Characterization of resins & polymers-II**
*(Polymer/ Surface coating)*

(4 x 4hrs/ week) Marks 100

1.) Synthesis of novolac, Resol, epoxy, amino, unsaturated polyester resin and their analysis
2). Manufacturing of molding powder of phenolic resin & Amino resin
3.) Making paper laminate of resol resin. To find free phenol & free formaline content of phenolic resin etc.

**PSP1C18:Pr 7 : Synthesis & Characterization of resins & polymers-III**
*(Polymer/ Surface coating)*

(2x2 hrs/ week) Marks 50

1.) Aqueous polymerization of acrylamide.
2.) Synthesis of modified amino, epoxy, modified phenolic resin. etc
3.) Core and shell polymer
4.) Manufacturing of Plastisol, organosol, Polyaniline synthesis. Etc.

**SEMESTER VI**

**THEORY**

**PST1C19: Spl 12: 1 Pigments & additives for Polymers**
*(Polymer/ Surface coating)*

(4 hrs/ week) Marks 100

Properties required in a pigment and extender (4)

Pigment dispersion basics (2)

Inorganic pigments such as titanium dioxide, zinc oxide, carbon black, chromate pigments, molybdate orange, chrome green, ultramarine blue, iron blue, cadmium red, pearlescent and other effect pigments (15)

corrosion inhibiting pigments, such as zinc phosphate, zinc and barium chromate pigments, ceramic pigments, metal flake pigments, extenders (9)
Theory of color formation in organic compounds, effect of auxiliary groups on the shade and hue of the pigment (Bathochromic and hyper chromic shift) (3)

Manufacture of Carbon black different grades such as furnace & channel black
Additives such as dispersion aids, UV stabilizers, antioxidants & antiozonents, processing/flow modifiers, different fillers such as calcium carbonate, mica, talc & others etc. (12)

PST1P01: Spl 13: Compounding and Polymer Processing- I (Polymer) (4 hrs/ week)
Marks 100

Basic Concept of Compounding and Processing; Concept of Master batches (2)

Classification and type of Additive for Plastics: Antioxidants, Light stabilizers, UV stabilizers, Lubricants and relative auxiliaries, Processing aids, Impact modifiers, Flame retardance, antistatic agents, PVC stabilizers and Plasticizers (3)

Colouration of Plastics: Chemistry, synthesis, properties and applications of –Inorganic Pigments such as Titanium dioxide, Zinc oxide, Lithophone, Carbon blacks, Metal oxide pigments, Chromium and Cadmium pigments, Ultra marine blue etc. (12)

Commonly used Organic pigments such as Antraquinone, Benzimidazolone dioxazines, Diazol lakes, lake reds, Lithol rubones, Monoazo lakes, Naphthol AS lakes, Naphthol AS, Perylenes, Phthalocyanines, Quinacridones, Dyes for transparent plastics. Dispersion of Pigments as well as agglomeration aspect should also be covered. In addition shrinkage and warpage will also be discussed. (15)

Processing Techniques: Basic of varies processing techniques such as
a) One-dimensional process is like Coating and Adhesives.
b) Extruders: single screw and twin screw extruders, Film blowing, coextrusion of multilayered films, Fiber spinning, Pipe extrusion, Extrusion of profiles, coextrusion of pipes, Extrusion of cable material, extrusion of sheet, Calendering, Thermoforming.
c) Molding: Injection molding Blow molding, Compression molding, Injection stretch blow molding, Resin transfer molding, Gas and water assisted injection molding and other three dimensional molding. (18)

Text books/ References

1) High performance pigments
2) Pigment Handbook Part 1, 2,3
3) Application properties of Pigments

Huge M. Smith
Patton
A. Karnik

Special 14:
PST1P02: Design and Fabrication of Moulds I (Polymers). (2 hrs/ week)
Marks 50

Compression moulds: Positive, semi-positive and flash mould with horizontal and vertical flash, arrangement of loading shoes, simple two plate and three-plate moulds, split moulds. (15)
Injection moulds: Two plate and three plates types, injection, venting, runner and gates, calculation of number of cavities, hot runner mould.
Computer softwares used in designing of molds & mold flow analysis

PST1P03: Special 15:
*Design and Fabrication of Moulds II (Polymers).*

Transfer moulds: Principles of integral pot, auxiliary ram and separated pot mould, calculation of number of cavities.

Extrusion dies: Extrusion of simple shapes tubing, cable covering and sheeting dies.

Mould fabrication: steels for moulding tools and their treatment include processes used for mould fabrication, finishing processes.

Heating systems for plates and moulds, measurement and control of temperature of moulds and dies, simple blow mould.

Introduction to computer aided design and software design aspects for moulds and dies.

**Reference Books:**
1. Plastic mould engineering handbook by Du Boi’s and I. Pribble.
2. Plastic moulds and Dies Laszlo Sors.
3. Injection moulds by Pye.
5. Extrusion dies design by M. V. Joshi.

**Elective I**
PST1P04: Structure property Relationship (Polymers/ Surface coatings)

General structural features of polymers: Effects of atoms types of bonds, bond dissociation energy and functional groups on properties of polymers

Configuration and conformation and structure properties of polymers

Molecular mass heterogeneity and structure properties

Polymers solutions: thermodynamics of dissolution, factors effecting dissolution and swelling of polymers, phase equilibrium of polymer-solvent systems, polymer solution, Florry-Huggins theory

Polymer chain flexibility: concept of flexibility, various factors deciding flexibility of polymers with case studies, properties of polymers affected by flexibility

Intermolecular orders: Amorphous, crystalline and oriented forms of polymers, crystallinity in polymers, factors affecting crystallinity, properties affected by crystallinity of polymers
Thermal properties of polymers: fire retardant polymers, factors affecting glass transition (Tg) temperature, heat stability etc. with case studies

Degradation and stabilization: various stresses acting on polymers and their influence, method of improving the stability of polymers with case study

Text/Source Books

PRACTICLES

PSP1P05: Pr 8: Design Of Moulds/ Drawing (Polymers)(Term Work) (2 x 4hours/week)
Marks 100

(1) Compressor Mould Design.
(2) Transfer Mould Design.
(3) Injection Mould Design.
(4) Extrusion Die Design.
(5) Blow Mould Design.
Pro E/ / Mold flow etc.

PSP1P06: Pr 9 Processing of Polymers-I (Polymers) (2hrs/ week)
Marks 50

1) Compounding of PVC
2) Manufacturing of FRP composites like epoxy ,polyester polymer.
3) To Study efficiency of heat stabilizer.
4) To study injection moulding & batch mixer, extrusion process
5) To study blown film extrusion plant.
SEMESTER VII

THEORY

PST1P07: Spl 16: Technology of Elastomers 1 (Polymer)  
(2 hrs / week)
Marks 50

Definition of elastomers and requirements of polymer to be elastomer: effect of molecular weight, tie points and glass transition temperature (Tg) (5)

characteristics. Different types of monomers used in synthesis of elastomers, classifications of elastomers, different processes used during life cycle of rubber like manufacture, storage, compounding, forming and vulcanization of rubbers, different ingredients used in it and functions of various compounding ingredient, various equipments used for compounding and their comparison (15)

Definitions of different terms like scorch, cure/ over cure & study of curing. Different types of vulcanization systems used for compounding and fillers used in elastomers, measurement of mooney viscosity and state of cure for rubber compound. (7)

Synthesis of various rubbers natural rubber/ synthetic polyisoprene (8)

Text/Source Books

PST1P08: Spl 17: Technology of Elastomers II (Polymer)  
(2 hrs / week)
Marks 50

Use of carbon black in rubbers, Manufacture of tyres & different steps involved in it. (7)

Synthesis of various rubbers styrene butadiene rubber, SBS block copolymer, nitrile rubber, EPR and EPDM rubber, polybutadiene rubber, butyl and neoprene/ chloroprene rubber, silicone rubber, etc. and their properties and applications (23)

Text/Source Books
PST1P09: Spl 18: Evaluation and Testing of Polymers (Polymer) (4hrs/ week)

Thermal properties of polymers: Glass transition temperature, melting temperature, heat distortion temperature, etc. Sample preparation, standardization, conditioning of sample, processability test, dynamic mechanical analysis, melt flow rate, Vicat softening temperature. Study of a dilatometer. Study of thermo-chemical analysis and differential scanning calorimeter and their applications to polymers with suitable examples. (6)

Structural evaluation of polymers: Principles, theories and applications to polymeric systems with suitable illustration of the following techniques: Fourier transform infrared spectrometry, Ultraviolet - visible spectrometry, Nuclear magnetic resonance spectrometry, Mass spectrometry, X-ray diffraction spectrometry, Gas chromatography. (16)

Molecular weight determination: Study of the respective principles, theories and applications by the following techniques: Gradient elution technique, Gel permeation chromatography, Vapor pressure osmometry, Cryoscopy and ebullioscopy. (8)

Viscosity of polymer solutions and polymers: Their significance, application to polymers using different viscometers. (2)

Electrical properties: Surface volume resistivity, Breakdown voltage, Arc resistance, Tan Delta, etc. The theory behind these phenomena, application to polymers and evaluation. (4)

Mechanical properties: Their principles and applications to polymers, Tensile strength, flexural strength, impact resistance, percentage elongation, Griffin theory, tear test, fatigue and wear, hardness, compressive strength time dependant properties like creep, stress, relaxation, etc. (8)

Environmental resistance: Stress cracking, effect of weathering, biological degradation, fire, radiation staining. (2)

Optical properties: Refractive index, gloss, colour matching, haze (2)

Fire test: Ignition of flame and spread, limiting oxygen index, rate of heat release, smoke toxicity test (4)

Adhesion test: Peel test, tension test, shear test. (2)

Microscopy: Scanning electron microscopy, travelling electron microscope. (2)

Identification of polymers using chemical methods (4)

Text/Source Books
3. Instrumental Methods by Dyer.
4. Developments in Polymer Characterization 1-5 by J. V. Dawkins
Elective II

PST1P10: Packaging & Decoration of plastics (Polymers) (2 hrs / week)
Marks 50


Decoration of plastics by printing, colouring, embossing, Metallizing films and paper etc.

6. Recycling:
   i. Packaging reduction, recycling and disposal guidelines.
   ii. Recycling methods.

PRACTICLES

SEMVII
PSP1P11: Pr 10 Analysis & Characterization of Polymers (4hrs/ week)
Marks 100

Analysis and identification of resins, plastics rubber sample like: PE, PP, EPR, Rosin, Epoxy, Alkyd, PET, ABS, SAN. PS, PVC, MF, UF, PC, PMMA, polyisoprene, SBR, Nylons, etc.

PSP1P12: Pr 11 Processing of Polymers-I I (2hrs/ week)
Marks 50

1. To find output of twin screw Extruder.
2. To study plastic welding, bonding process.
3. To study casting process of epoxy, acrylate resin etc.
4. To study thermoforming, corona discharge treatment method.

PST1C20:3 Seminar (Term Work) (2hrs/ week)
Marks 50

Students will be required to prepare critical reviews of selected topics in Chemical Technology and Allied subjects and submit in the form of standard typed report. The students will also be required to make an oral presentation of the review.
SEMESTER VIII

THEORY

PST1P13: Spl 19: Additives for Polymers (Polymer)  
(2hrs/ week)  
Marks 50  
Concepts of degradation of plastics due to UV, heat, ageing etc.; Use of additives to prevent this; stabilizers for PVC/ heat stabilizers, Chemical nature, composition and testing of various additives such as UV stabilizer etc.  
(8)  
Plasticizers, Lubricants, Processing aids & various rheology modifiers  
(4)  
Impact modifiers, classification of Fillers and Reinforcements such as organic/inorganic, particulate/fibrous, macro/micro/nano etc. Their treatments & use in different plastics their properties & use in plastics  
(12)  
Flame retardants, antistats, nucleating agents, blowing agents  
(5)  
Cross linking agents, antislip, antiblock, mold release and miscellaneous additives  
(3)

Text/Source Books

8. Crosslinking and Network Formation in Polymers, f. R. Jones  

PST1P14: Spl 20 Compounding and Polymer Processing- II (Polymer)  
(2hrs/ week)  
Marks 50  
Fillers and reinforcement: Varies materials such as Calcium carbonate, Dolomite, Silica Glass, Mica, Talc, Carbon, Clay etc. and reinforcement such as Inorganic and Organic fiber such as glass fiber, boron fiber, carbon fiber, aramide fibers, natural fibers etc. Functional fillers.  
(8)  
Polymer composites such as DMC, SMC, FRP etc. using fillers reinforcement and other polymeric fillers.  
(8)  
Reaction Injection Molding, Pultrusion, Pull winding.  
(5)
Simple flow models for extrusion: Equation of continuity, Equation of motion, role of Rheology in Polymer processing. Laminar flow of Newtonian and non-Newtonian fluids, through circular pipes between parallel plate and flow through annulus etc. Drag flow and pressure flow models for extrusion. Concept of model aspects applied to other processing techniques. (12)

Post extrusion techniques such as -Metallization, electroplating, Stamping, Welding and bonding, printing and painting on plastics etc. (10)

Crosslinking of thermoplastics materials. Cellular plastics (5)

Degradation and stabilization of plastics: Biostabilizers, metal deactivators environmental aspects of polymers. (7)

Characteristics of packaging films such as – Permeability, Heat seal, Printing, Drop impact etc. (5)

Text/Source Books
11. Understanding Compounding, R. H. Wildi and Maier, Hanser Publisher Inc, 1998.
27. Crosslinking and Network Formation in Polymers, f. R. Jones

Elective III
PST1P15:Advanced polymer science & technology: (Polymers) (2hrs/ week)
Marks 50

Reaction injection molding, water & gas assisted injection molding,
Specialty polymers such as LCPs & conducting polymers, IPNs, smart polymers etc.
Introduction to Polymer blends & alloys & polymer composites

Text/Source Books
Polymer Blends & Alloys by L. A. Utraki.

PRACTICALS

PSP1P16:Pr 12: Processing of Polymers III (Polymers) (4hrs/week)
Marks 100

1) To find Tg, Tc, and Tm of given resin by DSC.
2) To find MFI of given sample
3) To find molecular weight & PDI of given resin urging GPC.
4) To find moisture content of given sample. (quantitative analysis)
5) To Study DMTA, wealthiest test, salt spay, optical microscope. Surface
tensometer, XRD. Colour Values by spectro photometer.
6) Injection molding and compression molding of given sample
7) Mechanical Testing of polymer sample like tensile, izod/charpy
impact, % elongation etc.
8) To find Vicat softening point of given polymer sample.
9) To find electrical proportion like BDV, Arc resistance given sample

PSP1C21: Project Work (Term Work) 12hrs/week
Marks: 150

Every student will be required to submit a project report in a typed standard format on a topic
set by one or more faculty members. The object of the project work is to test the ability of the
student to tackle an investigational problem in his field of specialization. Every student will be
orally examined in the subject incorporated in his project report.