

## Department of Petrochemical Engineering

### List of Courses for Major Degree

### Polymer Science and Technology

S. N.	Sem.	Name of the course	Name of equivalent NPTEL course	NPTEL Sem. (Even/Odd)	Instructor's Name	Duration (weeks)	Credits
1	V	Polymer Science and Technology -I	--	--	--	12	4
2	VI	Polymer Science and Technology - II	--	--	--	12	4
3	VI	Polymer Science and Technology - III	--	--	--	12	4
4	VII	Thermoplastic and Thermoset Polymer Technology	--	--	--	12	4
5	VII	Compounding and Polymer Processing	--	--	--	08	4

**All above proposed courses are of specialized type. Therefore mapping and level of content match are difficult. Hence for these courses study material and digital content will have to be developed separately.**

## **Polymer Science and Technology –I**

### **Unit I**

Historical developments in polymeric materials, Basic concepts and definitions : monomer and functionality, oligomer, polymer , repeating unites, degree of polymerization, molecular weight and molecular weight distribution.

### **Unit II**

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

### **Unit III**

Raw material for synthetic polymers: Manufacturing of various fractions of crude petroleum important for polymer industry for

Raw Materials such as ethylene, propylene, butadiene, vinyl chloride, vinylidene dichloride, styrene, acrylic monomers like acrylic acid, acrylonitrile, methacrylic acid, methacrylates, acrylamide etc,

### **Unit IV**

Solvents for synthetic polymers such as alcohols, toluene, xylene, acetone, ketones, terpenes, chloromethanes etc. Evaluation of raw materials and reactants for synthesis and manufacturing of polymers. Polyacids such as phthalic acid, terephthalic acid, isomers and anhydrides etc.

### **Unit V**

Phenols, polyols and their modifications, Isocyanates, Amino Compounds and other petroleum based material

### **Texts/ Source Books**

1. Text book of Polymer Science by Billmeyer, John Wiley ans Sons 1984.
2. Polymer Chemistry by Malcolm P. Stevens, Oxford University Press, Inc, 1990.
3. Introduction to Polymer Science and Technology by H. S. Kaufman and J. J. Falcetta, Wiley – Interscience Publication, 1977
4. PVC Technology, A. S. Athalye and Prakash Trivedi, Multi-Tech Publishing Co, 1994

## **Polymer Science and Technology –II**

### **Unit I & II**

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.

### **Unit III & IV**

Molecular weight and its distribution determination ( $M_n$  to  $M_z$  & MWD), Carothers equation, states of polymers, transition temperatures such as  $T_g$ ,  $T_c$ ,  $T_m$ , solubility parameter, solution properties, temperature, good/ bad solvent.

### **Unit V**

Addition, condensation polymerization mechanism, Surface tension/ energy & contact angle measurements of different polymeric systems & their wettability with other substances.

### **Texts/ Source Books**

1. Text book of Polymer Science by Billmeyer, John Wiley and Sons 1984.
2. Encyclopedia of Polymer Science and Technology, John Wiley and Sons, Inc 1965.
3. Encyclopedia of Polymer Science and Engineering, John Wiley and Sons, Inc 1988.
4. Polymer Chemistry by Malcolm P. Stevens, Oxford University Press, Inc, 1990.
5. Introduction to Polymer Science and Technology by H. S. Kaufman and J. J. Falchetta, Wiley – Interscience Publication, 1977
6. Handbook of Polyethylene, A. J. Peacock, Marcel Dekker Inc, 2000
7. PVC Technology, A. S. Athalye and Prakash Trivedi, Multi-Tech Publishing Co, 1994

## **Polymer Science and Technology –III**

### **Unit I & II**

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

### **Unit III**

Condensation polymerization, different catalysts used case studies of condensation polymerization, Carothers equation, Comparison of these systems with advantages & disadvantages.

### **Unit IV**

Copolymerization, reactivity ratios & kinetics of copolymerization (copolymer composition equation). Rheological concepts of polymer solutions and melts, degradation plasticization  
Mixing operations: Typical agitation system, dissolution

### **Unit V**

Different advanced catalyst systems: Ziegler Natta catalyst & metallocene catalysts & their role in polyolefins, ATRP etc.

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1. Text book of Polymer Science by Billmeyer, John Wiley and Sons 1984.
2. Encyclopedia of Polymer Science and Technology, John Wiley and Sons, Inc 1965.
3. Encyclopedia of Polymer Science and Engineering, John Wiley and Sons, Inc 1988.
4. Polymer Chemistry by Malcolm P. Stevens, Oxford University Press, Inc, 1990.
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## **Thermoplastic and Thermoset Polymer Technology**

### **Unit I**

Polyethylenes; modified polyethylenes, Polypropylene and copolymer of PP, modified Polyolefins like crosslinked & filled polyolefins, Polyisobutylene & polyolefin plastomers etc.  
Engineering Polymers Polyesters such as PET, PBT, PTT, Polycarbonates, Polyacetal etc.

### **Unit II**

Polyethylenes; modified polyethylenes, Polypropylene and copolymer of PP  
Polyester Resins: Unsaturated polyesters resins, Raw material: poly-basic acids, polyfunctional glycols. 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 Molding compositions, DMC, SMC, fiber and film forming compositions.

### **Unit III**

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.

### **Unit IV**

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.

### **Unit V**

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.

### **Texts/ Source Books**

1. Text book of Polymer Science by Billmeyer, John Wiley and Sons 1984.
2. Encyclopedia of Polymer Science and Technology, John Wiley and Sons, Inc 1965.
3. Encyclopedia of Polymer Science and Engineering, John Wiley and Sons, Inc 1988.
4. Polymer Chemistry by Malcolm P. Stevens, Oxford University Press, Inc, 1990.
5. Introduction to Polymer Science and Technology by H. S. Kaufman and J. J. Falsetta, Wiley – Interscience Publication, 1977
6. Handbook of Polyethylene, A. J. Peacock, Marcel Dekker Inc, 2000
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## **Compounding and Polymer Processing**

### **Unit I & II**

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.

### **Unit III & IV**

Functional fillers.

Polymer composites such as DMC, SMC, FRP etc. using fillers reinforcement and other polymeric fillers, Composites Mechanics

Reaction Injection Molding, Pultrusion, Pull winding, Handlay up technique etc.

### **Unit V**

Post extrusion techniques such as - electroplating, Stamping, Welding and bonding Degradation and stabilization of plastics.

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2. Encyclopedia of Polymer Science and Technology, John Wiley and Sons, Inc 1965.
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