

**SARDAR PATEL UNIVERSITY
VALLABH VIDYANAGAR**



**SYLLABUS EFFECTIVE FROM: 2018-19
M.Sc. CHEMISTRY
SEMESTER-IV
INDUSTRIAL POLYMER CHEMISTRY**

(Total 650 marks)

Course Code	Course Title	Hours per week	Internal Marks	External Marks	Total Marks
PS04CIPC21	Spectroscopy of Polymers-II	4 hrs	30	70	100
PS04CIPC22	Manufacture Properties & Applications Of Thermoplastics	4 hrs	30	70	100
PS04CIPC23	Processing of Polymers	4 hrs	30	70	100
PS04CIPC24	Practical OR	8 hrs	30	70	100
PS04CIPC25	Project Work				
PS04CIPC26	Practical OR	8 hrs	30	70	100
PS04CIPC27	Project Work				
PS04CIPC28	General Viva-Voce	8 hrs	-	50	50
PS04EIPC21 Any One	Selected Topics in Polymers-II	4 hrs	30	70	100
PS04EIPC22	Preparation, Production and Testing of Polymers	4 hrs	30	70	100
Total Marks					650

* **Project work** (as optional) in place of practicals; to be offered to some of the students, based on their merit, interest and placement with the teachers (Marks : 200). The project shall have to be carried out under the allotted teacher(s) and a dissertation shall be submitted and will be assessed for internal (60 marks) and external (140 marks), in the usual manner.

Paper Code: PS04CIPC21	Total Credit: 4
Title Of Paper: Spectroscopy of Polymers - II	

Unit	Description in detail	Weightage (%)
1	<p>Infrared Spectroscopy: Fundamentals, experimental and applications to polymers-Theory and principles, molecular vibrations and calculations of vibrational frequencies, characteristic group absorptions in various polymeric compounds. Sample preparation.</p> <p>UV Spectroscopy: Theory and principles of electronic transition and UV absorption, chromophores and auxochromes, Woodward-Fieser rules for dienes and enones, characteristic absorptions in alkenes and alkynes, alcohols, ethers, amines, carbonyl compounds based on polymers. Effects of conjugation. Characteristic absorptions in aromatic polymeric compounds.</p>	25
2	<p>PMR Spectroscopy: Fundamentals, experimental and applications to polymers-Proton resonance condition, aspects of PMR spectra – number of signals, chemical shifts, shielding and deshielding, diamagnetic anisotropy, factors affecting chemical shifts, peak area and integration, splitting of the signals – spin-spin coupling, coupling constants – vicinal, geminal, long range and virtual couplings, Pople notation and spin assignments, chemical shift equivalence and magnetic equivalence, first order and second order spectra, complex PMR spectra, simplification of the PMR spectra – high resolution spectra, use of shift reagents, spin-spin decoupling-double resonance, proton exchange, deuterium exchange, Nuclear Overhauser Effect. Use of PMR spectra in differentiation of stereo isomers.</p>	25
3	<p>NMR Spectroscopy: Fundamentals, experimental and applications to polymers -¹³C- Difficulties and solution for recording ¹³C-NMR spectra, recording of ¹³CNMR spectra – scale, solvents, solvent signals and their positions, multiplicity, ¹³C-¹H coupling constant – proton coupled and decoupled ¹³C spectra, broad band decoupling, off resonance technique. Chemical shifts in ¹³C spectra – chemical shift calculation for alkanes, alkenes and alkynes, chemical shift calculation in internal and terminal substituted compounds, aromatic compounds. Use of ¹³C spectra in differentiating stereoisomers, Nuclear Overhauser Effect. ¹³C - DEPT spectra – differentiation in primary, secondary and tertiary carbons by DEPT – 45, DEPT – 90, DEPT – 135 spectra. 2D NMR Spectroscopy: Theory and principles of 2D NMR spectroscopy, interpretation of ¹H-¹H COSY, ¹H-¹³C HETCOR, HMQC, HMBC, INADEQUATE spectra.</p>	25
4	<p>Mass Spectroscopy, Fundamentals, experimental and applications to polymers: Theory and principles of mass spectroscopy, Instrumentation, low and high resolution mass spectra, Ionization techniques – Electron Impact (EI) ionization, Chemical Ionization (CI), Field Desorption (FD),</p>	25

Fast Ion Bombardment (FAB), Electrospray Ionization (ESI) and Matrix Assisted 25% Page 2 of 2 Laser Desorption/Ionization (MALDI). Determination of molecular weight and molecular formula, nitrogen rule, detection of molecular ion peak, metastable ion peak. Fragmentations – rules governing the fragmentations, McLafferty rearrangement. Interpretation of mass spectra of different class of POLYMER compounds – saturated and unsaturated hydrocarbons, aromatic hydrocarbons, alcohols, ethers, ketones, aldehydes, carboxylic acids, amines, amides, compounds containing halogens.
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Reference Books:-

- Polymer Spectroscopy A.H. Faweett. 1st Edition, John Wiley (1996)
- NMR of Polymers F. Bovey and P. Miran. First edition, Academic Press (1996)
- Spectroscopic Identification of Organic Compounds R. M. Silverstein and F. X. Webster, 6th edition (John Wiley & Sons)
- Introduction to Spectroscopy D. L. Pavia, G. M. Lampman and G. S. Kriz, 3rd edition (Thomson Brooks/Cole)
- NMR of Macromolecules: A practical approach G. C. K. Roberts, 1st Edition, Oxford University Press, (1993)
- Organic Spectroscopy William Kemp, 3rd edition (Palgrave)
- Organic Spectroscopy – Principles and Applications Jag Mohan, 2nd edition (Narosa Publishing House)
- Spectroscopy of Organic Compounds P. S. Kalsi, 5th edition (New Age International Publishers)

Paper Code: PS04CIPC22	Total
Title Of Paper: Manufacture Properties & Applications Of Thermoplastics	Credit: 4

Unit	Description in detail	Weightage (%)
1	Fundamentals of plastic, Hydrocarbon Polymers and Copolymers: Polyethylene- monomer preparation, polymerization, cross-linked polyethylene, Polypropylene- monomer preparation, polymerization, Hydrocarbon copolymers.	25
2	Other Carbon Chain Polymers: Polystyrene-monomer preparation, polymerization by bulk, solution, emulsion and suspension techniques and Styrene related acrylic polymers, Derivatives of Polyvinyl esters.	25
3	Heterochain Polymers: Polyamides-Nylon, 6, Nylon, 6, 6, Polyesters-Polymethyl methacrylate, Polyethylene terephthalate, Polycarbonate, Cellulosic Plastic- Cellulose nitrate, Cellulose acetate, Rayon.	25
4	Chlorine and Fluorine containing polymers- Polyvinyl fluoride, Polyvinylidene fluoride, Polychlorotrifluoroethylene, Polytetra fluoroethylene, Role of Additives in Plastics, Recycling of Plastics.	25

Reference Books:-

- Plastics Materials by J. A. Brydson (7th Edition), Elsevier
- Text Book of Polymer Science F. W. Billmeyer
- Industrial polymer handbook: Products, Processes, Applications, (V1,2,&3) Edited by E. S. Wilks, Wiley VCH Verlag GmbH, Weinheim.

Paper Code: PS04CIPC23	Total Credit: 4
Title of Paper: Processing of Polymers	

Unit	Description in detail	Weightage (%)
I	Introduction about processing in general, Classification of Polymer Processing, Rheology of Polymers, Rheological States of Polymer, Mixing and Compounding of Polymers, Important Factors of the Feed Stock during processing, Different blenders and mixers for polymers for mixing and compounding of polymeric materials	25%
II	Casting, Coating and Fibre Reinforced Plastics, Extrusion, Transfer Molding, Compression Molding	25%
III	Injection Molding, Rotational Molding, Static Molding, Blow Molding, Spinning Processes	25%
IV	Thermoforming, Foaming, Calendering, Welding and Joining, Finishing Operations	25%

Reference Books:

1. Principles of Polymer Processing (2nd Editions), Z. Tadmor and C.G. Gogos, A John Wiley & Sons. Inc. Publication
2. Mixing and Compounding of Polymers: Theory and Practice (2nd Edition), Manas-Zloczower, Ica, Carl Hanser Verlag GmbH & Co. KG.
3. Plastic Engineering, R. J.Crawford, Pergamon Press
4. Polymer Processing, D.H.Morton-Jones, Champman & Hall Inc.
5. Handbook of Plastic Processes, Chalres A. Harper, Wiley

Paper Code: PS04CIPC24	Total Credit: 4
Title of Paper: Practical	

Description	Weightage (%)
• Identification of Plastics and Rubbers	100%

Reference Books:

1. Rubber and Plastics Testing, P. Kluckow, Champman & Hall Publ., UK
2. Handbook of Analysis of Synthetic Polymers and Plastics, J. Urbanski, Ellis Horwood Ltd.(Publ.)

3. Introduction of Chemical Analysis of Plastics, A Krause and A. Lenge, Lliffe books Ltd. London
4. Polymer Characterization, E. Shroder et al., Hanser Publ.
5. Experiments in Polymer Science, D. G. Hundiwale, V. D. Athawale, U. R. Kapadi and V. V. Gite, New Age International Publihers
6. Macromolecules: Vol. 2: Synthesis, Materials and Technology, H. G. Elias, Springer

Paper Code: PS04CIPC26	Total Credit: 4
Title of Paper: Practical	

Description in Detail	Weightage (%)
Mechanical Testing of Polymers	50%
Synthesis of monomers, plasticizers and curing agents	50%

Reference Books:

1. Rubber and Plastic Testing by J.A. Brydson and KJ. Saunders
2. Handbook of Analysis of Synthetic Polymers and Plastics by J. Urbansky
3. Introduction of Chemical Analysis of Plastics by A. Krause and A. Lenge
4. Polymer Characterization by - E. Shroder, et al Hanser Publ.

OR

PS04CIPC25 and PS04IPC27 :

Project work (as optional) in place of practicals; to be offered to some of the students, based on their merit, interest and placement with the teachers (Marks : 200). The project shall have to be carried out under the allotted teacher(s) and a dissertation shall be submitted and will be assessed for internal (60 marks) and external (140 marks), in the usual manner.

Paper Code: PS04CIPC28	Total Credit: 1
Title of Paper: Viva Voce	

Description in detail	Weightage (%)
Viva Voce From the Subjects Studied in Semester - IV	100%

Paper Code: PS04EIPC29	Total
Title Of Paper: Selected Topics in Polymers- II	Credit: 4

Unit	Description in detail	Weightage (%)
1	Fundamental of paints, Introduction, Principle of paint formulation, Properties of coating, Paint mixer, Characteristic, properties of Pigments Formulation of Paints and Varnishes	25
2	Paints resins: .Natural and Synthetic- Rosin & Resin esters, Phenolic, Rubber & latexes, Coumarone-indene, Terpene, Terpene-phenolic, Alkyd, phthalic alkyd, vinyl etc.	25
3	Synthetic Adhesives: Traditional, Pressure Sensitive and Hot melt Adhesives: Block and Graft copolymers: Ion Exchange polymers.	25
4	Engineering Plastics: Introduction to high temperature and fire resistant polymers- Polyacetals, Poly butylene-terphthalate, Polyphenylene oxide, Polyphenylenesulfide, Polyether ketone, Polyether ether ether ketone (PEEK)	25

Reference Books:-

1. Paint manufacture by J. R. Kapuria
2. High Temperature Resistance Polymers by -A. H. Frazer, Intersci. Pubs.
3. Specialty polymers by-R. W. Dyson, 1998, 2nd Edition.
4. Macromolecules, Vol. II by - H.GElias, Plenum Press, New York
5. Hand-book of Adhesives and Sealants by - Edward M. PetriteM.C.Graw-Hill Pub

Paper Code: PS04EIPC30	Total
Title Of Paper: Preparation, Production and Testing of Polymers	Credit: 4

Unit	Description in detail	Weightage (%)
1	Preparation of Monomers: Introduction: Monomers capable of chain polymerization, Saturated hydrocarbons from natural gas, Acetylene, Ethylene, Aromatic Hydrocarbons, Chemical processes used in industrial organic synthesis, Processing of hydrocarbon gases, Chemical processing of ethylene hydrocarbons, Chemical processing of aromatic hydrocarbons, Methanol, Phenol, Formaldehyde, Styrene, 1,3-butadiene	25
2	Production of Polymers: Ethenoid plastics and Resins, Cellulose plastics and resins, Silicone resins and plastics.	25
3	Effect of Polymer Structure on Properties: Molecular Weight, Strength, Plastic Deformation, Physical state of Polymer, Elastic Property, Chemical Resistance, Solubility, Intermolecular forces in Monomers and Polymers, Mechanical behavior of polymers	25
4	Physical testing of plastics and elastomers before and after processing	25

Reference Books

1. Plastics Materials J. A. Brydson (7th Edition), Elsevier
2. Text Book of Polymer Science by F. W. Bill Meyer
3. Industrial polymer handbook: Products, Processes, Applications, (V1,2,&3) Edited by E. S. Wilks, Wiley VCH Verlag GmbH, Weinheim.
4. Rubber Technology by Morris Morton, Van Nostrand Publ.
5. Handbook of Plastics Testing and Failure Analysis (3rd Edition) , Vishu Shah, Wiley Publ.