

**ARDAR PATEL UNIVERSITY**  
**Vallabh Vidyanagar, Gujarat**  
**(Reaccredited with 'A' Grade by NAAC (CGPA 3.25))**  
**Syllabus with effect from the Academic Year 2022-2023**

**PROGRAMME STRUCTURE**  
**Master of Science in Chemistry**  
**MSc (Industrial Polymer Chemistry) Semester: III**

<p>Programme Outcome (PO) - For MSc Chemistry Programme</p>	<p>Master of Science program provides extended theoretical and practical knowledge of different science subjects. Master of Science programme at Sardar Patel University is designed keeping the overall back ground preparation in mind for the student to either seek a job or to become an entrepreneur. The students, after completion of Bachelor of Science can select the master's programme in the subject they have had at the final year or in a related discipline (depending upon eligibility criteria prescribed by university).</p> <p><b>Programme outcomes: At the end of the program, the students will be able to</b></p> <ol style="list-style-type: none"> <li>1. Have a deep understanding of both the theoretical and practical concepts in the respective subject.</li> <li>2. Understand laboratory processes and use scientific equipments and work independently.</li> <li>3. Develop research temperament as a consequence of their theory and practical learning.</li> <li>4. Communicate scientific information in oral and written form.</li> <li>5. Understand the issues related to nature and environmental contexts and think rationally for sustainable development.</li> <li>6. The students are able to handle unexpected situations by critically analyzing the problem.</li> </ol>
<p>Programme Specific Outcome (PSO) - For MSc Chemistry Semester - III</p>	<p>Students will have a firm foundation in the fundamentals and application of current chemical and scientific theories including those in Analytical Inorganic Chemistry, Organic Chemistry, Physical Chemistry, Chemistry and Industrial polymer Chemistry.</p> <p>After completing M.Sc. chemistry program, students will be able to:</p> <ul style="list-style-type: none"> <li>■ Demonstrate and apply the fundamental knowledge of the basic principles in various fields of Chemistry.</li> <li>■ Apply knowledge to build up small scale industry for developing endogenous product.</li> <li>■ Collaborate effectively on team-oriented projects in the field of chemistry or other related fields.</li> <li>■ Communicate scientific information in a clear and concise manner both orally and in writing.</li> <li>■ Inculcate logical thinking to address a problem and become result oriented with a positive attitude.</li> </ul> <ul style="list-style-type: none"> <li>■ Enhance the scientific temperament among the students so as to develop a research culture and implementation of the policies to tackle the burning issues at global and local level.</li> <li>■ Apply the knowledge to develop the sustainable and eco-friendly technology.</li> </ul>

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	<ul style="list-style-type: none"> <li>■ Take up global level research opportunities to pursue Ph.D programme targeted approach and specific competitive exams conducted by service commission</li> <li>■ Accept enormous job opportunities at all level of chemical industries, pharmaceutical industries and placements in R &amp; D.</li> </ul>
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To Pass	At least 40% Marks in the University Examination in each paper and 40% Marks in the aggregate of University and Internal examination in each course of Theory, Practical & 40% Marks in Viva-voce.
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Course Type	Course Code	Name of Course	Type of Course	T /P	Credit	Hours per Week	Exam Duration in hrs	Component of Marks		
								Internal	External	Total
								Total/Passing	Total/Passing	Total/Passing
Core Course	PS03CIPC51	Spectroscopy of Polymers	EM & EN	T	4	4	3	30/10	70/28	100/40
	PS03CIPC52	Manufacture Properties and Applications of Thermosets	EM&EN	T	4	4	3	30/10	70/28	100/40
	PS03CIPC53	Polymer Structure & Properties	EM	T	4	4	3	30/10	70/28	100/40
Core Course (Any One)	PS03CIPC54	Practicals <b>OR</b>	EM&SD	P	4	8	6	30/10	70/28	100/40
	PS03CIPC55	Project Work	EM&SD	P	4	8		30/10	70/28	100/40
Core Course (Any One)	PS03CIPC56	Practicals <b>OR</b>	EM&SD	P	4	8	6	30/10	70/28	100/40
	PS03CIPC57	Project Work	EM&SD	P	4	8		30/10	70/28	100/40
Core Course	PS03CIPC58	Comprehensive Viva		-	1	1			50/20	50/20
Elective Course (Any one)	PS03ECHE51	Separation methods	EM&EN	T	4	4	3	30/10	70/28	100/40
	PS03ECHE52	Analytical techniques in Materials characterization	EM&EN	T	4	4	3	30/10	70/28	100/40
	PS03ECHE53	Applications of Inorganic Chemistry in Industry	EM&EN	T	4	4	3	30/10	70/28	100/40
	PS03ECHE54	Selected Topics in Advanced Inorganic Chemistry-I	EM&EN	T	4	4	3	30/10	70/28	100/40

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	PS03ECHE55	Mechanical and Electrical Properties of Polymers	EM&EN	T	4	4	3	30/10	70/28	100/40
	PS03ECHE56	Selected Topics in Polymers-I	EM&EN	T	4	4	3	30/10	70/28	100/40
	PS03ECHE57	Advanced Characterization Techniques	EM&EN	T	4	4	3	30/10	70/28	100/40
	PS03ECHE58	Selected Topics in Physical Chemistry-II	EM&EN	T	4	4	3	30/10	70/28	100/40
	PS03ECHE59	Selected Topics in Organic Chemistry	EM&EN	T	4	4	3	30/10	70/28	100/40
	PS03ECHE60	Occupational Practices	EM&EN	T	4	4	3	30/10	70/28	100/40
					25					650
Add-on Course		MOOCs course from Swayam Portal								

EMPLOYABILITY = EM, ENTREPRENEURSHIP = EN and SKILL DEVELOPMENT = SD

\* 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.



Master of Science, Industrial Polymer Chemistry  
M. Sc. Industrial Polymer Chemistry, Semester – III

Course Code	PS03CIPC51	Title of the Course	Spectroscopy of Polymers
Total Credits of the Course	4	Hours per Week	4

Course Objectives:	1. To introduce the materials characterization techniques to the students and to help the students to understand the instrumentation aspects 2. To provide a detailed understanding of data interpretation.
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Course Content		
Unit	Description	Weightage* (%)
1.	<b>Infrared Spectroscopy: Fundamentals, Experimental and Applications to Polymers:</b> -Theory and principles, molecular vibrations and calculations of vibrational frequencies, characteristic group absorptions in various polymeric compounds. Sample preparation. <b>UV Spectroscopy:</b> 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.	25
2.	<b>PMR Spectroscopy: Fundamentals, Experimental and Applications to Polymers:</b> -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.	25
3.	<b>NMR Spectroscopy: Fundamentals, Experimental and Applications to Polymers:</b> - <sup>13</sup> C- Difficulties and solution for recording <sup>13</sup> C-NMR spectra, recording of <sup>13</sup> CNMR spectra – scale, solvents, solvent signals and their positions, multiplicity, <sup>13</sup> C-1H	25





	coupling constant – proton coupled and decoupled <sup>13</sup> C spectra, broad band decoupling, off resonance technique. Chemical shifts in <sup>13</sup> C spectra – chemical shift calculation for alkanes, alkenes and alkynes, chemical shift calculation in internal and terminal substituted compounds, aromatic compounds. Use of <sup>13</sup> C spectra in differentiating stereoisomers, Nuclear Overhauser Effect. <sup>13</sup> C - 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- <sup>13</sup> C HETCOR, HMQC, HMBC, INADEQUATE spectra.	
4.	<b>Mass Spectroscopy, Fundamentals, experimental and applications to polymers:</b> 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), 25 Page 3 of 7 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.	25

Teaching-Learning Methodology	The institutional course consists of classroom lessons and video projection of the lessons is also used in classroom. The students are also able to obtain directly the above material from the University Digital Library Service.
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Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%





Course Outcomes: Having completed this course, the learner will be able to know

1.	Spectroscopic techniques and applications
2.	Structural elucidation of organic and polymeric compounds by combined application of UV, IR, PMR, NMR and Mass Spectroscopy.
3.	Fundamentals of Solid-State NMR and its application to polymers.
4.	Tacticity analysis of polymers by IR and NMR spectroscopy.

Suggested References:

Sr. No.	References
1.	Polymer Spectroscopy A.H. Faweett. 1st Edition, John Wiley (1996)
2.	NMR of Polymers F. Bovey and P. Miran. First edition, Academic Press (1996)
3.	Spectroscopic Identification of Organic Compounds R. M. Silverstein and F. X. Webster, 6th edition (John Wiley & Sons)
4.	Introduction to Polymer Chemistry by R. B. Seymour, Mc – Graw – Hill, New York
5.	Introduction to Spectroscopy D. L. Pavia, G. M. Lampman and G. S. Kriz, 3rd edition (Thomson Brooks/Cole)
6.	NMR of Macromolecules: A practical approach G. C. K. Roberts, 1st Edition, Oxford University Press, (1993)
7.	Organic Spectroscopy William Kemp, 3rd edition (Palgrave)
8.	Organic Spectroscopy – Principles and Applications Jag Mohan, 2nd edition (Narosa Publishing House)
9.	Spectroscopy of Organic Compounds P. S. Kalsi, 5th edition (New Age International Publishers)

On-line resources to be used if available as reference material

On-line Resources

<https://www.youtube.com/watch?v=Ra4P0XCBkXs>

<https://www.youtube.com/watch?v=ID1bEJrJmLk>





Master of Science, Industrial Polymer Chemistry  
M. Sc. Industrial Polymer Chemistry, Semester – III

Course Code	PS03CIPC52	Title of the Course	Manufacture Properties and Applications of Thermosets
Total Credits of the Course	4	Hours per Week	4

Course Objectives:	To impart basic knowledge on the synthesis of various thermoset resins and its applicability.
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Course Content		
Unit	Description	Weightage* (%)
1.	<b>Introduction of thermosets:</b> General properties and Uses of Thermosets, Cross-linking reactions, Viscosity and Thermal control during cross-linking. <b>Polyesters:</b> Linear unsaturated polyester, Linear saturated polyesters of low molecular weight, Linear saturated polyesters of high molecular weight, Network polyesters	25
2.	<b>Phenol Formaldehyde Polymers:</b> Raw materials of Phenolics, Various phenol processes, Other Phenols and Aldehydes, 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, Applications of phenolics and other modified phenolic resins. <b>Urea Formaldehyde Resins:</b> (Raw Materials, 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, Process of conversion of low molecular weight to high molecular weight, Applications and other modified urea formaldehyde resins.	25
3.	<b>Melamine-formaldehyde Resins:</b> Raw Materials, 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, Process of conversion of low molecular weight to high molecular weight, Applications and other melamine formaldehyde modified resins <b>Epoxy resins:</b> Basic raw materials like 2,2-bis (4'-hydroxyphenyl)propane) and 1-chloro-2,3,-epoxy-propane, Resin preparations, Different cross-linking agents used for curing, Modified epoxides & epoxy resins for advanced applications, Resin-modified	25





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	epoxies (phenol-formaldehyde resins, amino resins, esterified epoxies), Epoxies based on glycidyl ethers and non-glycidyl ethers	
4.	<b>Polyurethanes:</b> Basic components: diisocyanates and diols, different diisocyanates and diols used for making resin, Resinification, Isocyanate reactions involving active hydrogen compounds, Preparation and Properties of Flexible Foams, Preparation and Properties of Rigid Foams, Solid polyurethane elastomers (Cast elastomers, Millable elastomers and Thermoplastic elastomers) <b>Polyimides:</b> Basic Components, Synthesis, Properties and Applications.	25

Teaching-Learning Methodology	The institutional course consists of classroom lessons and video projection of the lessons is also used in classroom. The students are also able to obtain directly the above material from the University Digital Library Service.
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Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Formulation for manufacturing, properties and applications of variety of thermoset materials
2.	Effect of variation in the quantities & type of curing agents & curing condition on the properties of thermoset material

Suggested References:	
Sr. No.	References
1.	Polymer Chemistry, Seymour and Carraher, Marcel Dekker,2003.
2.	Polymer Science and Technology, R.O.Ebewel, CRC Press, BocaRaton, New York







3.	Thermosets: Structure, Properties and Applications (2 <sup>nd</sup> Edition), Q. Guo (Wood head Publishing in Materials), Elsevier
4.	Handbook of Thermoset Resins, D. Ratna, I. Smithers Publ., UK
5.	Handbook of Thermoset Plastics (2 <sup>nd</sup> Edition), S. Goodman, Noyes Publication, USA

On-line resources to be used if available as reference material

On-line Resources

<https://www.youtube.com/watch?v=zPkhdQL2Eos>

[https://www.youtube.com/watch?v=PSSK5VGcC\\_0](https://www.youtube.com/watch?v=PSSK5VGcC_0)

<https://www.youtube.com/watch?v=Nt9jsWEk8aU>





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**Master of Science, Industrial Polymer Chemistry**  
**M. Sc. Industrial Polymer Chemistry, Semester – III**

Course Code	PS03CIPC53	Title of the Course	Polymer Structure & Properties
Total Credits of the Course	4	Hours per Week	4

Course Objectives:	To provide the students with basic knowledge of polymer materials, so that they would be able to understand and distinguish between variety of materials based on their structure and properties.
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Course Content		
Unit	Description	Weightage* (%)
1.	Polymerization reactions: Chain polymerization, Ionic polymerization, Stereo specific polymerization, Polycondensation, Polymer solutions: Criteria and thermodynamics of solubility, fractionation of polymers by solubility, Methods of determining molecular mass based on colligative properties: End group analysis, VPO, HSMO etc.	25
2.	Methods for determination of molecular mass based on size: Light scattering, Viscometry, Gel permeation chromatography (GPC). Molecular size and shape: Effect of molecular weight on, Processibility, Mechanical properties, Thermal properties, Electrical properties and Chemical properties,	25
3.	Intermolecular order: Crystallinity; Factors determining crystallinity, effect of crystallinity on properties, Orientation; Processing effect on orientation, effect of orientation on properties, Intermolecular bonding	25
4.	Polymer chain flexibility: General fundamental concepts, Restriction of rotation, Internal rotations in macromolecules, Configuration and conformations, Thermodynamics of factors affecting chain flexibility.	25

Teaching-Learning Methodology	The institutional course consists of classroom lessons and video projection of the lessons is also used in classroom. The students are also able to obtain directly the above material from the University Digital Library Service.
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Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Upon completion of the course, the student will be able to understand various structure of polymers and their effect on different properties of polymers.
2.	They can also able to predict the different properties of polymers using group contribution technique.
3.	Understanding the intermolecular order and chain flexibility of polymers.

Suggested References:	
Sr. No.	References
1.	Plastic Materials, J.A. Brydson, Newmens Butterworths London,1975
2.	Textbook of Polymer Science, F.W. Billmeyer, Interscience Publ., New York
3.	Properties of Polymers, D. W. Van Krevelen, Elsevier Publ.,1976
4.	Polymer, Structure, Properties & Applications, R.D Deanin, Cohne Books,1972
5.	Macromolecules-I, Hans-Georg Elias, Plenum Press, New York,1984
6.	Polymer Characterization, E. Schroder, G. Muller et al, Hanser Publ., New York

On-line resources to be used if available as reference material
On-line Resources
<a href="https://www.youtube.com/watch?v=jUDyjFXOb8s">https://www.youtube.com/watch?v=jUDyjFXOb8s</a>





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**Master of Science, Industrial Polymer Chemistry**  
**M. Sc. Industrial Polymer Chemistry, Semester – III**

Course Code	PS03CIPC54	Title of the Course	Practicals
Total Credits of the Course	4	Hours per Week	8

Course Objectives:	Studies synthesis of polymeric materials, emphasizing interrelationships of chemical pathways, process conditions and micro architecture of molecules produced.
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Course Content		
	Description	Weightage* (%)
	Synthesis of Polymers	100

Teaching-Learning Methodology	Laboratory work
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Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Practical Examination (As per CBCS R.6.8.3)	30%
2.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand the basic concept of chemical reactions and polymerization reactions.

Suggested References:	
Sr.	References





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No.	
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, Liffel books Ltd.London
4.	Polymer Characterization, E. Shroder et al., HanserPubl.
5.	Experiments in Polymer Science, D. G. Hundiwale, V. D. Athawale, U.R. Kapadi and V. V. Gite, New Age International Publishers
6.	Macromolecules: Vol. 2: Synthesis, Materials and Technology, H. G.Elias, Springer

On-line resources to be used if available as reference material

On-line Resources





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**Master of Science, Industrial Polymer Chemistry**  
**M. Sc. Industrial Polymer Chemistry, Semester – III**

Course Code	PS03CIPC55	Title of the Course	Project Work
Total Credits of the Course	04	Hours per Week	08

Course Objectives:	To assess the overall knowledge of the student in the relevant subjects covered in core as well as elective courses.
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Course Content	
Description	Weightage* (%)
Research work in laboratory on a topic given by the supervisor	100%

Teaching-Learning Methodology	Laboratory exercise and thesis writing
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Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Presentation and Viva-voce Examination (As per CBCS R.6.8.3)	30%
2.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to proceed for literature survey, synthesis and characterization of compounds/ materials using modern analytical and spectroscopic techniques and their study for various applications. They will be trained in research for pursuing higher studies. They will get training for working in research in academic and industries.

Suggested References: Published research articles on given research topic.





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On-line resources to be used if available as reference material

Published papers by reputed publishers like American Chemical Society, Royal Society of Chemistry, Wiley, Elsevier, etc.

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**Master of Science, Industrial Polymer Chemistry**  
**M. Sc. Industrial Polymer Chemistry, Semester – III**

Course Code	PS03CIPC56	Title of the Course	Practicals
Total Credits of the Course	4	Hours per Week	8

Course Objectives:	Studies synthesis of polymeric materials, emphasizing interrelationships of chemical pathways, process conditions and micro architecture of molecules produced.
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Course Content		
	Description	Weightage* (%)
	Characterization of Polymers	50
	Purity of Monomers	50

Teaching-Learning Methodology	Laboratory work
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Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand the basic concept of chemical reactions and polymerization reactions.
2.	Understand the basics of laboratory reagents/solutions and their preparations with respect to percent solution, molar and normal solutions too.







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Suggested References:

Sr. No.	References
1.	Handbook of Analysis of Synthetic Polymers and Plastics, J. Urbanski, Ellis Horwood Ltd. (Publ.)
2.	Introduction of Chemical Analysis of Plastics, A Krause and A. Lenge, Liffé books Ltd. London
3.	Polymer Characterization, E. Shroder et al., Hanser Publ.
4.	Experiments in Polymer Science, D. G. Hundiwale, V. D. Athawale, U.R. Kapadi and V. V. Gite, New Age International Publishers, New Delhi

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**Master of Science, Industrial Polymer Chemistry**  
**M. Sc. Industrial Polymer Chemistry, Semester – III**

Course Code	PS03CIPC57	Title of the Course	Project Work
Total Credits of the Course	04	Hours per Week	08

Course Objectives:	To assess the overall knowledge of the student in the relevant subjects covered in core as well as elective courses.
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Course Content	
Description	Weightage* (%)
Research work in laboratory on a topic given by the supervisor	100%

Teaching-Learning Methodology	Laboratory exercise and thesis writing
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Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Presentation and Viva-voce Examination (As per CBCS R.6.8.3)	30%
2.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to proceed for literature survey, synthesis and characterization of compounds/ materials using modern analytical and spectroscopic techniques and their study for various applications. They will be trained in research for pursuing higher studies. They will get training for working in research in academic and industries.

Suggested References: Published research articles on given research topic.





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On-line resources to be used if available as reference material

Published papers by reputed publishers like American Chemical Society, Royal Society of Chemistry, Wiley, Elsevier, etc.

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**Master of Science, Industrial Polymer Chemistry**  
**M. Sc. Industrial Polymer Chemistry, Semester – III**

Course Code	PS03CIPC58	Title of the Course	Comprehensive Viva
Total Credits of the Course	01	Hours per Week	01

Course Objectives:	To assess the overall knowledge of the student in the relevant subjects covered in core as well as elective courses.
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**PROGRAMME STRUCTURE**  
**Master of Science in Chemistry**  
**MSc (Industrial Polymer Chemistry) Semester: IV**

<p>Programme Outcome (PO) - For MSc Chemistry Programme</p>	<p>Master of Science program provides extended theoretical and practical knowledge of different science subjects. Master of Science programme at Sardar Patel University is designed keeping the overall back ground preparation in mind for the student to either seek a job or to become an entrepreneur. The students, after completion of Bachelor of Science can select the master's programme in the subject they have had at the final year or in a related discipline (depending upon eligibility criteria prescribed by university).</p> <p><b>Programme outcomes: At the end of the program, the students will be able to</b></p> <ol style="list-style-type: none"><li>1. Have a deep understanding of both the theoretical and practical concepts in the respective subject.</li><li>2. Understand laboratory processes and use scientific equipments and work independently.</li><li>3. Develop research temperament as a consequence of their theory and practical learning.</li><li>4. Communicate scientific information in oral and written form.</li><li>5. Understand the issues related to nature and environmental contexts and think rationally for sustainable development.</li><li>6. The students are able to handle unexpected situations by critically analyzing the problem.</li></ol>
<p>Programme Specific Outcome (PSO) - For MSc Chemistry Semester - IV</p>	<p>Students will have a firm foundation in the fundamentals and application of current chemical and scientific theories including those in Analytical Inorganic Chemistry, Organic Chemistry, Physical Chemistry, Chemistry and Industrial polymer Chemistry.</p> <p>After completing M.Sc. chemistry program, students will be able to:</p> <ul style="list-style-type: none"><li>■ Demonstrate and apply the fundamental knowledge of the basic principles in various fields of Chemistry.</li><li>■ Apply knowledge to build up small scale industry for developing endogenous product.</li><li>■ Collaborate effectively on team-oriented projects in the field of chemistry or other related fields.</li><li>■ Communicate scientific information in a clear and concise manner both orally and in writing.</li><li>■ Inculcate logical thinking to address a problem and become result oriented with a positive attitude.</li><li>■ Enhance the scientific temperament among the students so as to develop a research culture and</li></ul>





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	<p>implementation of the policies to tackle the burning issues at global and local level.</p> <ul style="list-style-type: none"> <li>■ Apply the knowledge to develop the sustainable and eco-friendly technology.</li> <li>■ Take up global level research opportunities to pursue Ph.D programme targeted approach and specific competitive exams conducted by service commission</li> <li>■ Accept enormous job opportunities at all level of chemical industries, pharmaceutical industries and placements in R &amp; D.</li> </ul>
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To Pass	At least 40% Marks in the University Examination in each paper and 40% Marks in the aggregate of University and Internal examination in each course of Theory, Practical & 40% Marks in Viva-voce.
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Course Type	Course Code	Name of Course	Type of Course	T / P	Credit	Hours per Week	Exam Duration in hrs	Component of Marks		
								Internal	External	Total
								Total/Passing	Total/Passing	Total/Passing
Core Course	PS04CIPC51	Instrumental Methods of Analysis	EM & EN	T	4	4	3	30/10	70/28	100/40
	PS04CIPC52	Manufacture Properties & Applications Of Thermoplastics	EM& EN	T	4	4	3	30/10	70/28	100/40
	PS04CIPC53	Processing of Polymers	EM& EN	T	4	4	3	30/10	70/28	100/40
Core Course (Any One)	PS04CIPC54	Practical OR	EM&SD	P	4	8	6	30/10	70/28	100/40
	PS04CIPC55	Project Work	EM&SD	P	4	8	8	30/10	70/28	100/40
Core Course (Any One)	PS04CIPC56	Practical OR	EM&SD	P	4	8	6	30/10	70/28	100/40
	PS04CIPC57	Project Work	EM&SD	P	4	8		30/10	70/28	100/40
Core Course	PS04CIPC58	Comprehensive Viva		-	1	1			50/20	50/20
Elective Course (Any one)	PS04ECHE51	Environmental Chemistry and analysis	EM& EN	T	4	4	3	30/10	70/28	100/40
	PS04ECHE52	Analysis of Pharmaceuticals drugs	EM& EN	T	4	4	3	30/10	70/28	100/40
	PS04ECHE53	Selected Topics in Advanced Inorganic Chemistry-II	EM& EN	T	4	4	3	30/10	70/28	100/40
	PS04ECHE54	Inorganic Polymers and Inorganic Materials	EM& EN	T	4	4	3	30/10	70/28	100/40



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	PS04ECHE55	Selected Topics in Polymers-III	EM& EN	T	4	4	3	30/10	70/28	100/40
	PS04ECHE56	Selected Topics in Polymers- II	EM& EN	T	4	4	3	30/10	70/28	100/40
	PS04ECHE57	Surface Chemistry and Catalysis	EM& EN	T	4	4	3	30/10	70/28	100/40
	PS04ECHE58	Introduction to Different Materials	EM& EN	T	4	4	3	30/10	70/28	100/40
	PS04ECHE59	Topics in Organic Chemistry	EM& EN	T	4	4	3	30/10	70/28	100/40
	PS04ECHE60	Applied Organic Chemistry	EM& EN	T	4	4	3	30/10	70/28	100/40
					25					650
Add-on Course		MOOCs course from Swayam Portal								

**EMPLOYABILITY = EM, ENTREPRENEURSHIP = EN and SKILL DEVELOPMENT = SD**

\* **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 (60marks) and external (140marks), in the usual manner.



Master of Science, Industrial Polymer Chemistry  
M. Sc. Industrial Polymer Chemistry, Semester – IV

Course Code	PS04CIPC51	Title of the Course	Instrumental Methods of Analysis
Total Credits of the Course	4	Hours per Week	4

Course Objectives:	<ul style="list-style-type: none"><li>• Detail understanding of the morphology of polymers, structural properties, interactions and characterization of some polymers by spectroscopic techniques like Atomic absorption, Atomic and Flame Emission, Electron etc..</li><li>• To understand Microscopic Techniques, Thermal and Mechanical properties studies, their fundamentals, experiments and applications to various commercial important polymers.</li></ul>
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Course Content		
Unit	Description	Weightage* (%)
1.	<b>Atomic Absorption/Atomic and Flame Emission Spectroscopy:</b> Absorption of radiation by atoms; equipment: radiation sources (Hollow cathode lamps and electrode less discharge lamps); atomizers (Flame and carbon); wavelength selector and detectors; interferences in atomic absorption spectroscopy; applications and problems: qualitative and quantitative analysis. equipment: inductively coupled plasma spectrometer and flame photometer; applications and problems.	25
2.	<b>Electron Spectroscopy:</b> Introduction to electron spectroscopy (ESCA Auger and UPS); principle and theory of ESCA; instrumentation; chemical shifts, satellite peaks and spectral splitting; application and problems. Principle and electron transition of Auger electron spectroscopy; equipment; applications and problems.	25
3.	<b>Microscopic Techniques:</b> Introduction to scanning electron microscopy (SEM), Scanning tunneling microscopy (STM) and atomic force microscopy (AFM); basic principles and theory; instrumentation and operating parameters and applications.	25
4.	<b>Polymer analysis:</b> Study of thermal and mechanical properties by Differential Scanning Calorimetry, Thermo gravimetric Analysis, Thermo mechanical Analysis, Dynamic Mechanical Analyzer and Universal Testing machine.	25





<b>Teaching-Learning Methodology</b>	The course consists of classroom lessons, the resolution of numerical example relating to the issues addressed and discussions with students. Demonstration of actual spectra of particular sophisticated instruments. Video projection of the lessons is used in classroom. The students are also able to obtain directly the above material from the Department/University/Digital Library Service. Department is well equipped with such sophisticated instruments and hence students may get visit and demonstration with it.
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<b>Evaluation Pattern</b>		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

<b>Course Outcomes:</b> Having completed this course, the learner will be able to	
1.	Detail study about the Atomic Absorption/Atomic and Flame Emission Spectroscopy techniques and its applications and understanding to the polymers. Characteristic absorptions in aromatic polymeric compounds.
2.	Thorough study about the Electron Spectroscopy technique and its applications and understanding to the polymers. Use of PMR spectra in differentiation of stereo isomers.
3.	Detailed study on Microscopy analysis technique and its applications and understanding to the polymers. Differentiation study in morphology of various amorphous and crystalline parts of the polymers. Specific applicability of various spectroscopic techniques to polymers and knowledge of various applications used for improving properties of polymers.
4.	Thermal study and mechanical study are very important for the various commodity plastic materials for the end use.

<b>Suggested References:</b>	
Sr. No.	References
1.	Polymer Spectroscopy A.H. Fawcett. 1st Edition, John Wiley (1996)
2.	NMR of Polymers F. Bovey and P. Miran. First edition, Academic Press (1996)
3.	Spectroscopic Identification of Organic Compounds R. M. Silverstein and F. X. Webster, 6th edition (John Wiley & Sons)
4.	Introduction to Polymer Chemistry by R. B. Seymour, Mc – Graw – Hill, New York
5.	Introduction to Spectroscopy D. L. Pavia, G. M. Lampman and G. S. Kriz, 3rd edition (Thomson Brooks/Cole)
6.	NMR of Macromolecules: A practical approach G. C. K. Roberts, 1st Edition, Oxford University Press, (1993)
7.	Organic Spectroscopy William Kemp, 3rd edition (Palgrave)
8.	Organic Spectroscopy – Principles and Applications Jag Mohan, 2nd edition (Narosa Publishing House)
9.	Spectroscopy of Organic Compounds P. S. Kalsi, 5th edition (New Age International Publishers)

<b>On-line resources to be used if available as reference material</b>
On-line Resources : You Tube Videos on different topics of the syllabus are easily available on a single click.





**Master of Science, Industrial Polymer Chemistry**  
**M. Sc. Industrial Polymer Chemistry, Semester – IV**

Course Code	PS04CIPC52	Title of the Course	Manufacture Properties & Applications Of Thermoplastics
Total Credits of the Course	4	Hours per Week	4

Course Objectives:	<ul style="list-style-type: none"><li>• Foundation in understanding the basic commodity monomer and polymer reactions, its manufacture, properties and applications.</li><li>• Moreover, will be able to learn technology in the field of polymer chemistry in the various aspects of plastic technology.</li><li>• Understand the responsibilities in manufacturing, testing, and quality control in the polymer industries and contribute towards the progress of the industry</li></ul>
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Course Content		
Unit	Description	Weightage* (%)
1.	Fundamentals of thermoplastic materials, Hydrocarbon Polymers and Copolymers: Polyethylene (PE)- monomer preparation, Industrial polymerization processes, cross-linked polyethylene (XLPE), Polypropylene (PP)- monomer preparation, polymerization, Hydrocarbon copolymers.	25
2.	Carbon-Carbon Chain Polymers: Polystyrene- styrene monomer preparation, polymerization of styrene by bulk, solution, emulsion and suspension techniques, 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- Chloro/ Fluoro polymers: Polyvinyl fluoride(PVF), Polyvinylidene fluoride, Polychlorotrifluoroethylene (PCTFE), Polytetra fluoroethylene (PTFE), Role of Additives in Plastics, Recycling of Plastics.	25

Teaching-Learning Methodology	The course consists of classroom lessons, the resolution of numerical example relating to the issues addressed and discussions with students. Demonstration of actual plastic specimen and articles of particular Polymers. Video projection of the lessons is used in classroom. The students are also able to obtain directly the above material from the Department/University/Digital Library Service.
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<b>Evaluation Pattern</b>		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

**Course Outcomes:** Having completed this course, the students will be able to

1.	Understanding the fundamentals of the thermoplastics materials, preparation, properties & application of various hydrocarbon plastics, which are very important commercial needs.
2.	Industrial process for manufacturing of various commercially important polymers like polystyrene, polyvinyl esters, Nylon,6, Nylon,6,6, cellulosic plastics, chloro and fluoro polymers etc.
3.	Recycling methods of various plastic scrape by separation and roll of additives in plastics.

**Suggested References:**

Sr. No.	References
1.	Plastics Materials by J. A. Brydson (7th Edition), Elsevier
2.	Text Book of Polymer Science F. W. BillMeyer
3.	Industrial polymer handbook: Products, Processes, Applications, (V1,2,&3 ) Edited by E. S. Wilks, Wiley VCH Verlag GmbH, Weinheim.

On-line resources to be used if available as reference material

On-line Resources : You Tube Videos on different topics of the syllabus are easily available on a single click.





**Master of Science, Industrial Polymer Chemistry**  
**M. Sc. Industrial Polymer Chemistry, Semester – IV**

Course Code	PS04CIPC53	Title of the Course	Processing of Polymers
Total Credits of the Course	<b>4</b>	Hours per Week	4

Course Objectives:	<ul style="list-style-type: none"><li>• To study general processing equipments for the various plastics.</li><li>• Understanding of important factors of the feed stock during processing,</li><li>• Detailed study on processing techniques like casting, coating, fibre reinforced plastics, extrusion, injection moulding, compression moulding, blowing process etc.</li></ul>
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Course Content		
Unit	Description	Weightage* (%)
1.	Introduction about processing in general, Classification of Polymer Processing, Rheological States of Polymer, Mixing and Compounding of Polymers, Important Factors of the Feed Stock, Different blenders and mixers for mixing and compounding of polymeric materials	25
2.	Casting, Coating, Fibre Reinforced Plastics, Transfer Molding, Compression Molding.	25
3.	Extrusion, Injection Molding, Rotational Molding, Static Molding, Blow Molding	25
4.	Thermoforming, Foaming, Calendaring, Welding and Joining	25

Teaching-Learning Methodology	The course consists of classroom lessons, the resolution of numerical example relating to the issues addressed and discussions with students. Demonstration of some actual parts of processing equipments and its functions. Video projection of the lessons is used in classroom. The students are also able to obtain directly the above material from the Department/University/Digital Library Service.
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<b>Evaluation Pattern</b>		
<b>Sr. No.</b>	<b>Details of the Evaluation</b>	<b>Weightage</b>
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

<b>Course Outcomes:</b> Having completed this course, the students will be able to understand	
1.	the basic concept of polymer rheology, visco elastic properties of polymers and need for processing.
2.	the role additives and their properties in raw material to process and get desire end product.
3.	the use of various techniques to give shapes to polymeric materials for various end user applications. .

<b>Suggested References:</b>	
Sr. No.	References
1.	Principles of Polymer Processing (2nd Editions), Z. Tadmor and C.G. Gogos, A John Wiely & 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

On-line resources to be used if available as reference material
On-line Resources : You Tube Videos on different topics of the syllabus are easily available on a single click.

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**Master of Science, Industrial Polymer Chemistry**  
**M. Sc. Industrial Polymer Chemistry, Semester – IV**

Course Code	PS04CIPC54	Title of the Course	Practicals
Total Credits of the Course	4	Hours per Week	8

Course Objectives:	To train the student to identify plastics and rubbers.
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Course Content		
	Description	Weightage* (%)
	Identification of Plastics and Rubbers	100

Teaching-Learning Methodology	Laboratory work
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Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Practical Examination (As per CBCS R.6.8.3)	30%
2.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Identify the polymeric materials on the basis of different test methods.

Suggested References:	
Sr. No.	References
1.	Rubber and Plastics Testing, P. Kluckow, Champman& Hall Publ.,UK





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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, Liffel books Ltd.London
4.	Polymer Characterization, E. Shroder et al., HanserPubl.
5.	Experiments in Polymer Science, D. G. Hundiwale, V. D. Athawale, U.R. Kapadi and V. V. Gite, New Age International Publishers
6.	Macromolecules: Vol. 2: Synthesis, Materials and Technology, H. G.Elias, Springer

On-line resources to be used if available as reference material

On-line Resources





**Master of Science, Industrial Polymer Chemistry**  
**M. Sc. Industrial Polymer Chemistry, Semester – IV**

Course Code	PS04CIPC55	Title of the Course	Project Work
Total Credits of the Course	04	Hours per Week	08

Course Objectives:	To assess the overall knowledge of the student in the relevant subjects covered in core as well as elective courses.
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Course Content	
Description	Weightage* (%)
Research work in laboratory on a topic given by the supervisor	100%

Teaching-Learning Methodology	Laboratory exercise and thesis writing
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Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Presentation and Viva-voce Examination (As per CBCS R.6.8.3)	30%
2.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to proceed for literature survey, synthesis and characterization of compounds/ materials using modern analytical and spectroscopic techniques and their study for various applications. They will be trained in research for pursuing higher studies. They will get training for working in research in academic and industries.
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Suggested References: Published research articles on given research topic.
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On-line resources to be used if available as reference material

Published papers by reputed publishers like American Chemical Society, Royal Society of Chemistry, Wiley, Elsevier, etc.

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**Master of Science, Industrial Polymer Chemistry**  
**M. Sc. Industrial Polymer Chemistry, Semester – IV**

Course Code	PS04CIPC56	Title of the Course	Practicals
Total Credits of the Course	4	Hours per Week	8

Course Objectives:	1.To understand polymer testing related to short term as well as long term mechanical properties. 2. To understand the utilization of starting materials of polymers and applications.
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Course Content		
	Description	Weightage* (%)
	Mechanical Testing of Polymers	50
	Synthesis of monomers, plasticizers and curing agents	50

Teaching-Learning Methodology	Laboratory work
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Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Practical Examination (As per CBCS R.6.8.3)	30%
2.	University Examination	70%
Course Outcomes: Having completed this course, the learner will be able to		
1.	Student should be able to understand in details about mechanical properties of plastics material & different types of test method like tensile, flexural, creep, VSP, HDT etc	
2.	To study the basic concept of rheology properties like viscosity and molecular weight of polymeric materials in the dilute solution form.	
3.	Applicability of various additives in polymer applications.	





Suggested References:

Sr. No.	References
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.

On-line resources to be used if available as reference material

On-line Resources

<https://www.youtube.com/watch?v=DSr4G3l8e78>

<https://www.youtube.com/watch?v=qrlPE1VewN8>

<https://www.youtube.com/watch?v=I0aYfmbGmSA>





**Master of Science, Industrial Polymer Chemistry**  
**M. Sc. Industrial Polymer Chemistry, Semester – IV**

Course Code	PS04CIPC57	Title of the Course	Project Work
Total Credits of the Course	04	Hours per Week	08

Course Objectives:	To assess the overall knowledge of the student in the relevant subjects covered in core as well as elective courses.
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Course Content	
Description	Weightage* (%)
Research work in laboratory on a topic given by the supervisor	100%

Teaching-Learning Methodology	Laboratory exercise and thesis writing
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Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Presentation and Viva-voce Examination (As per CBCS R.6.8.3)	30%
2.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to proceed for literature survey, synthesis and characterization of compounds/ materials using modern analytical and spectroscopic techniques and their study for various applications. They will be trained in research for pursuing higher studies. They will get training for working in research in academic and industries.

Suggested References: Published research articles on given research topic.





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On-line resources to be used if available as reference material

Published papers by reputed publishers like American Chemical Society, Royal Society of Chemistry, Wiley, Elsevier, etc.

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**Master of Science, Industrial Polymer Chemistry**  
**M. Sc. Industrial Polymer Chemistry, Semester – IV**

Course Code	PS04CIPC58	Title of the Course	Comprehensive Viva
Total Credits of the Course	01	Hours per Week	01

Course Objectives:	To assess the overall knowledge of the student in the relevant subjects covered in core as well as elective courses.
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