

**Dr. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,  
CHHATRAPATI SAMBAJINAGAR.**



**CIRCULAR NO.SU/ Sci./College/NEP-2020/104/2024**

It is hereby inform to all concerned that, In continuation circular No.SU./Revised B.Sc./NEP/72/2024/25588-96 dated 29.04.2024, the revised syllabi prepared by the Board of Studies/Ad-hoc Boards and recommended by the Dean, Faculty of Science & Technolgy, the Academic Council at its meeting held on 08 April 2024 has accepted **the following Revised B.Sc. Course Structure & Curriculum** as per direction by the State Government dated on 13 March 2024 under the Faculty of Science & Technology (as per National Education Policy – 2020) run at the Affiliated Colleges, Dr.Babasaheb Ambedkar Marathwada University as appended herewith.

Sr.No.	Courses	Semester
1	Physics	Ist and IInd semester
2	Instrumentation Practice	Ist and IInd semester
3	Electronics	Ist and IInd semester
4	Mathematics	Ist and IInd semester
5	Industrial Chemistry	Ist and IInd semester
6	Agrochemical Fertilizer	Ist and IInd semester
7	Horticulture	Ist and IInd semester
8	Biochemistry	Ist and IInd semester
9	Botany	Ist and IInd semester
10	Zoology	Ist and IInd semester
11	Biotechnology	Ist and IInd semester
12	bioinformatics	Ist and IInd semester
13	Microbiology	Ist and IInd semester
14	Dairy Science & TEchnology	Ist and IInd semester
15	Statistics	Ist and IInd semester
16	computer Science	Ist and IInd semester
17	Geology	Ist and IInd semester
18	Chemistry	Ist and IInd semester
19	Analytical Chemistry	Ist and IInd semester
20.	Polymer Chemistry	Ist and IInd semester
21.	Environmental Science	Ist and IInd semester
22.	Fishery Science	Ist and IInd semester

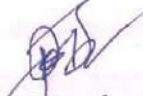
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This is effective from the Academic Year 2024-25 and onwards.

All concerned are requested to note the contents of this circular and bring the notice to the students, teachers and staff for their information and necessary action.

University Campus,  
Chhatrapati Sambhajanagar  
-431 004.  
REF.NO. SU/SCI./2024/27128-35  
Date:-27.05.2024.

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**Deputy Registrar,  
Academic Section.**

**Copy forwarded with compliments to :-**

- 1] **The Principal of all concerned Colleges,**  
Dr. Babasaheb Ambedkar Marathwada University,
- 2] **The Director, University Network & Information Centre, UNIC, with a request to upload this Circular on University Website.**

**Copy to :-**

- 1] The Director, Board of Examinations & Evaluation, Dr. Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajanagar.
- 2] The Section Officer, [B.Sc. Unit] Examination Branch, Dr. Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajanagar.
- 3] The Programmer [Computer Unit-1] Examinations, Dr. Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajanagar.
- 4] The Programmer [Computer Unit-2] Examinations, Dr. Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajanagar.
- 5] The In-charge, [E-Suvidha Kendra], Rajarshi Shahu Maharaj Pariksha Bhavan, Dr. Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajanagar.
- 6] The Public Relation Officer, Dr. Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajanagar.
- 7] The Record Keeper, Dr. Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajanagar.

**Dr. Babasaheb Ambedkar Marathwada University**  
**Chhatrapati Sambhajinagar- 431001**



**B.Sc. Degree Programme**

(Three Year / Four Years (Hons) / Four Years (Hons with Research))

# **Course Structure and Syllabus for B. Sc. First Year**

**(Revised)**

(AS PER NEP-2020)

**Subject (Major): POLYMER CHEMISTRY**

**Effective from 2024-25**

## PREFACE

As we stand on the threshold of a new era in education, the dawn of the National Education Policy 2020 illuminates our path toward a holistic, inclusive, and progressive educational landscape. The Bachelor of Science (B. Sc.) curriculum outlined herein reflects the ethos and aspirations of this transformative policy, aiming to equip learners with the knowledge, skills, and values necessary to thrive in the dynamic world of the 21st century.

At its core, the National Education Policy 2020 envisions an educational framework that is learner-centric, multidisciplinary, and geared towards fostering creativity, critical thinking, and innovation. It emphasizes the integration of knowledge across disciplines, breaking down traditional silos to encourage holistic understanding and application of concepts. The Bachelor of Science (B. Sc.) curriculum embodies these principles by offering a diverse array of courses spanning various scientific domains, while also incorporating interdisciplinary studies to nurture well-rounded graduates capable of addressing complex challenges with agility and insight.

Furthermore, the curriculum is designed to promote experiential learning, research, and hands-on exploration, recognizing the importance of practical engagement in deepening understanding and cultivating real-world skills. Through laboratory work, field experiences, internships, and project-based learning opportunities, students will have the chance to apply theoretical knowledge in practical settings, develop problem-solving abilities, and cultivate a spirit of inquiry and discovery.

Integral to the National Education Policy 2020 is the commitment to inclusivity, equity, and access to quality education for all. The Bachelor of Science ( B. Sc.) curriculum reflects this commitment by embracing diversity in perspectives, backgrounds, and experiences, and by fostering an inclusive learning environment where every student feels valued, supported, and empowered to succeed.

Moreover, the curriculum emphasizes the cultivation of ethical values, social responsibility, and global citizenship, instilling in students a sense of accountability towards society and the environment. By integrating courses on ethics, sustainability, and social sciences, the Bachelor of Science ( B. Sc.) program aims to produce graduates who are not only proficient in their respective fields but also compassionate, ethical leaders committed to making a positive impact on the world.

As we embark on this journey of educational transformation guided by the National Education Policy 2020, the Bachelor of Science (B. Sc.) curriculum stands as a testament to our collective vision of a more equitable, inclusive, and enlightened society. It is our hope that through rigorous academics, innovative pedagogy, and unwavering dedication to excellence, we can inspire the next generation of scientists, scholars, and change-makers to realize their full potential and contribute meaningfully to the advancement of knowledge and the betterment of humanity.

**Structure of B. Sc. (Three / Four Years Honours / Honours with Research Degree) Programme with Multiple Entry and Exit Options**

**Subject (Major): Polymer Chemistry**

**BSc First Year: 1<sup>st</sup> Semester**

Course Type	Course Code	Course Name	Teaching Scheme (Hrs / Week)		Credits Assigned		Total Credits
			Theory	Practical	Theory	Practical	
Major ( Core) M1 Mandatory	DSC-1	Basic Concepts in Polymer Chemistry-1	2		2		2+2 = 4
	DSC-2	Lab course -1		4		2	
Major ( Core) M2 Mandatory	DSC-1		2		2		2+2 = 4
	DSC-2	Practical based on DSC-1		4		2	
Major ( Core) M3 Mandatory	DSC-1		2		2		2+2 = 4
	DSC-2	Practical based on DSC-1		4		2	
Generic / Open Elective ( GE/OE) (Choose any one from pool of courses) <b>It should be chosen compulsorily from the faculty other than that of Major</b>	GE/OE-1	To be chosen from other faculty	2		2		2
SEC ( Skill Enhancement Courses) (Choose any one from pool of courses)	SEC-1	<b>A. Water Treatment and Analysis</b> <b>B. IT Application for polymer and polymer processing</b>	1		1		2
	SEC-2	Practicals based on SEC-1 <b>A. Water Treatment and Analysis</b> <b>B. IT Application for polymer and polymer processing</b>		2		1	
AEC, VEC, IKS	AEC-1	English ( Common for all the faculty)	2		2		2+2 =4
	IKS-1	Choose any one from pool of courses	2		2		
OJT/ FP/CEP/CC/RP	CC-1	Health and Wellness ( Common for all the faculty)		4		2	2
			<b>13</b>	<b>18</b>	<b>13</b>	<b>09</b>	<b>22</b>

GE/OE-1 : **Plastic Waste Management** ( This is a 2 credit theory course available for the students from other faculty )

## BSc First Year: 2<sup>nd</sup> Semester

Course Type	Course Code	Course Name	Teaching Scheme (Hrs / Week)		Credits Assigned		Total Credits
			Theory	Practical	Theory	Practical	
Major ( Core) M1 Mandatory	DSC-3	Basic concepts of polymer chemistry 2	2		2		2+2 = 4
	DSC-4	Lab course -2		4		2	
Major ( Core) M2 Mandatory	DSC-3		2		2		2+2 = 4
	DSC-4	Practical based on DSC-3		4		2	
Major ( Core) M3 Mandatory	DSC-3		2		2		2+2 = 4
	DSC-4	Practical based on DSC-3		4		2	
Generic / Open Elective ( GE/OE) (Choose any two from pool of courses) It should be chosen compulsorily from the faculty other than that of Major	GE/OE-2	To be chosen from other faculty	2		2		2
VSC ( Vocational Skill Courses) (Choose any one from pool of courses)	VSC-1	A) Recycling and Waste Management – 1 (Polymer Chemistry) B) Soap and Detergent	1		1		2
	VSC-2	Practicals based on VSC- A) Recycling and Waste Management – 1 (Polymer Chemistry) B) Soap and Detergent		2		1	
AEC, VEC, IKS	AEC-1	English ( Common for all the faculty)	2		2		2+2 =4
	VEC-1	Constitution of India ( Common for all the faculty)	2		2		
OJT/ FP/CEP/CC/RP	CC-2	Yoga Education / Sports and Fitness ( Common for all the faculty)		4		2	2
			13	18	13	09	22
Exit Option : Award of UG Certificate in 3 Majors with 44 credits and an additional 4 credits of core NSQF course / Internship OR continue with Major and Minor							

**GE/OE-2 : Polymer: Basic Concepts, Applications and Its Socio-environmental Impact**  
 (( This is a 2 credit theory course available for the students from other faculty )

Students will have to choose any three subjects as a **Major 1, Major 2, Major 3**, from Basket 1 under the Faculty of Science and Technology.

Students will be having three subject options of equal credits (instead of Major and / or minor verticals) in the first year. Students will have to select / declare choice of one subject **as a major subject** in the beginning of second year **out of three major options M1, M2 and M3 (which were opted in the first year).**

### **Detailed Illustration of Courses included in 1<sup>st</sup> and 2<sup>nd</sup> semester:**

- 1) **Major (Core)** subject are mandatory.

DSC-1 : This is a 2 credit theory course corresponding to Major ( core) subject

DSC-2 : This is a 2 credit practical course based on DSC-1

DSC-3 : This is a 2 credit theory course corresponding to Major ( core) subject

DSC-4 : This is a 2 credit practical course based on DSC-3

- 2) **Generic / Open Elective (GE/OE):** (Needs to be chosen (any two) from pool of courses available at respective college). **These courses should be chosen compulsorily from faculty other than that of Major.**

GE/OE -1 : This is a 2 credit theory course should be chosen compulsorily from faculty other than that of Major.

GE/OE -2 : This is a 2 credit theory course should be chosen compulsorily from faculty other than that of Major.

- 3) **SEC (Skill Enhancement Courses) :** Choose any one from pool of courses. These courses needs to be designed to enhance the technical skills of the students in specific area.

**SEC-1 :** This is a 1 credit theory course to enhance the technical skills of the students in specific area.

**SEC-2 :** This is a 1 credit practical course based on SEC-1.

- 4) **VSC (Vocational Skill Courses) :** Choose any one from pool of courses. These courses should be based on Hands on Training corresponding to Major (core) subject.

**VSC-1 :** This is a 1 credit theory course based Hands on Training corresponding to Major ( core) subject.

**VSC-2 :** This is a 1 credit practical course based on VSC-1

- 5) **AEC (Ability Enhancement courses):** The focus of these courses should be based on linguistic and communication skills.

**AEC-1 : English**

This is a 2 credit theory course based on linguistic proficiency. It will be common for all the faculty.

**AEC-2 : English**

This is a 2 credit theory course based on linguistic proficiency. It will be common for all the faculty.

- 6) **IKS (Indian Knowledge System)** : The courses related to traditional and ancient culture of India will be included in this section. The respective college will have to choose one of the courses from the pool of courses designed by the University.

**IKS-1 : To be chosen from the pool of courses designed by the University**

This is a 2 credit theory course based on Indian Knowledge System. It will be common for all the faculty

- 7) **VEC (Value Education Courses)**: The courses such as understanding India, Environmental Science / Education, Digital and Technological solutions etc will be part of Value Education Courses.

**VEC-1 : Constitution of India**

This is a 2 credit theory course based on value education. It will be common for all the faculty

- 8) **CC (Curricular Courses)**: The courses such as Health and wellness, Yoga education, Sports and Fitness, Cultural activities, NSS/NCC, Performing Arts.

**CC-1 : Health and Wellness**

This is a 2 credit practical course based on Co-curricular activities. It will be common for all the faculty

**CC-2 : Yoga education / Sports and Fitness**

This is a 2 credit practical course based on Co-curricular activities. It will be common for all the faculty

## **General Guidelines for Course Selection**

- 1) The Major subject is the discipline or course of main focus, bachelors degree shall be awarded in that discipline / subject.
- 2) Students will have to choose any three subjects as a Major 1, Major 2, Major 3, from **Basket 1** under the Faculty of Science and Technology (based on the available options in the respective college).
- 3) Students will be having three subject options of equal credits (instead of Major and / or minor verticals) in the first year.
- 4) In the beginning of second year, students will have to select / declare choice of **one major subject** and **one minor subject** from three major options **M1, M2 and M3 (which were opted in the first year)**
- 5) Once the students finalize their **Major Subject** and **Minor Subject** in the beginning of the second year of the programme, they shall pursue their further education in that particular subject as their **Major and Minor** subjects. Therefore, from second year onwards curriculum of the Major and Minor subjects shall be different.
- 6) Students are required to select **Minor subject** from **other discipline of the same faculty**
- 7) Students are required to select **Generic /Open Elective** (vertical 3 in the credit framework) **compulsorily from the faculty different than that of their Major / Minor subjects.**
- 8) Vocational Skill Courses and Skill Enhancement Courses (VSC and SEC) shall be related to the Major subject
- 9) Curriculum of Ability Enhancement Courses (AEC), Value Education Courses (VEC), Indian Knowledge System (IKS), and Co-curricular Courses (CC) will be provided by the University separately.

## Programme Educational Objectives (PEOs) :

Programme Educational Objectives (PEOs) for the Bachelor of Science Curriculum under the National Education Policy 2020:

1. **Mastery of Discipline-Specific Knowledge:** Graduates of the Bachelor of Science program will demonstrate a deep understanding of fundamental principles, theories, and methodologies in their chosen scientific discipline, enabling them to analyze complex problems, propose innovative solutions, and contribute to advancements in their field.
2. **Interdisciplinary Proficiency:** Graduates will possess the ability to integrate knowledge and skills from multiple scientific disciplines, fostering a holistic approach to problem-solving and innovation. They will be equipped to address multifaceted challenges by drawing upon diverse perspectives and methodologies.
3. **Critical Thinking and Analytical Skills:** Graduates will develop strong critical thinking abilities, enabling them to evaluate information rigorously, analyze data effectively, and make informed decisions based on evidence. They will demonstrate proficiency in applying logical reasoning and scientific methods to solve problems and generate new knowledge.
4. **Leadership and Innovation:** Graduates will demonstrate leadership qualities and entrepreneurial mindset, capable of initiating and driving positive change in their organizations and communities. They will exhibit creativity, resilience, and adaptability, harnessing innovation to address complex challenges and seize opportunities for growth and advancement.
5. **Global Citizenship and Cultural Sensitivity:** Graduates will possess a global perspective and cultural sensitivity, recognizing the interconnectedness of diverse communities and the importance of collaboration across borders. They will engage in cross-cultural dialogue, embrace diversity, and contribute to the advancement of knowledge and understanding on a global scale.

These Programme Educational Objectives serve as guiding principles for the Bachelor of Science curriculum, reflecting our commitment to nurturing well-rounded graduates who are prepared to excel in their careers, contribute to society, and lead meaningful lives in a rapidly changing world.

## Programme Outcomes (POs) :

The National Education Policy (NEP) 2020 for India emphasizes several key aspects for Bachelor of Science (B.Sc.) programs, aiming to produce graduates who are not only well-versed in their respective disciplines but also equipped with skills necessary for holistic development and employability. While specific program outcomes may vary between institutions and disciplines within B.Sc. programs, here are some common outcomes aligned with NEP 2020:

- **PO1. The citizenship and society:** Apply broad understanding of ethical and professional skill in science subjects in the context of global, economic, environmental and societal realities while encompassing relevant contemporary issues.
- **PO2. Environment and sustainability:** Apply broad understanding of impact of science subjects in a global, economic, environmental and societal context and demonstrate the knowledge of, and need for sustainable development.
- **PO3. Ethics:** Apply ability to develop sustainable practical solutions for science subject related problems within positive professional and ethical boundaries.
- **PO4. Individual and team work:** Function effectively as a leader and as well as team member in diverse/ multidisciplinary environments.
- **PO5. Communication:** Communicate effectively on complex science subject related activities with the scientific community in particular and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- **PO6. Project management and finance:** Demonstrate knowledge and understanding of the first principles of science and apply these to one's own work as a member and leader in a team, to complete project in any environment.
- **PO7. Life-long learning:** Recognize the need for lifelong learning and have the ability to engage in independent and life-long learning in the broadest context of technological change.

These program outcomes align with the broader goals of NEP 2020 to transform higher education in India and prepare students for the challenges and opportunities of the 21st century. Board of Studies designing B.Sc. curricula are encouraged to incorporate these outcomes into their program objectives and learning outcomes.

## Programme Specific Outcomes (PSOs):

**PSO1; Core competency:** The Polymer chemistry graduates will know the fundamental concepts of chemistry and applied chemistry. These fundamental concepts would reflect the latest understanding of the field, and therefore, are dynamic in nature and require frequent and time-bound revisions.

**PSO2; Communication skills:** Polymer chemistry graduates will possess minimum standards of communication skills expected of a Polymer Chemistry graduate in the country. They are expected to read and understand the documents with in-depth analyses and logical arguments. Graduates are expected to be well-versed in speaking and communicating their idea/finding/concepts to wider audience.

**PSO3; Critical thinking:** Polymer Chemistry graduates are expected to know basics of cognitive biases, mental models, logical fallacies, scientific methodology and constructing cogent scientific arguments.

**PSO4; Psychological skills:** Polymer Chemistry Graduates are expected to possess basic psychological skills required to face the world at large, as well as the skills to deal with individuals and students of various sociocultural, economic and educational levels. Psychological skills may include feedback loops, self-compassion, self-reflection, goal-setting, interpersonal relationships, and emotional management.

**PSO5; Problem-solving:** Polymer Chemistry Graduates will be equipped with problem-solving philosophical approaches that are pertinent across the disciplines.

**PSO6; Analytical reasoning:** Polymer Chemistry Graduates acquire formulate cogent arguments and spot logical flaws, inconsistencies, circular reasoning etc.

**PSO7; Research-skills:** Polymer Chemistry Graduates will be keenly observant about what is going on in the natural surroundings to awake their curiosity. Polymer Chemistry Graduates are expected to design a scientific experiment through statistical hypothesis testing and other *a priori* reasoning including logical deduction.

**PSO8; Teamwork:** Polymer Chemistry Graduates will be team players, with productive cooperations involving members from diverse socio-cultural backgrounds.

**PSO9; Digital Literacy:** Polymer Chemistry Graduates are expected to be digitally literate for them to enroll and increase their core competency via e-learning resources such as MOOC and other digital tools for lifelong learning. Polymer Chemistry Graduates should be able to spot data fabrication and fake news by applying rational skepticism and analytical reasoning.

**PSO10; Moral and ethical awareness:** Polymer Chemistry Graduates will be responsible citizen of India and be aware of moral and ethical baseline of the country and the world. They are expected to define their core ethical virtues good enough to distinguish what construes as illegal and crime in Indian constitution. Emphasis be given on academic and research ethics, including fair Benefit Sharing, Plagiarism, Scientific Misconduct and so on.

**PSO11; Leadership readiness:** Polymer Chemistry Graduates are expected to be familiar with decision making process and basic managerial skills to become a better leader. Skills may include defining objective vision and mission, how to become charismatic inspiring leader and so on.

# Semester I

**DSC-1 : ( Title of Paper) BASIC CONCEPTS OF POLYMER CHEMISTRY-1**

Total Credits : 02

Total Contact Hours : 30 Hrs

Maximum Marks : 50

**Learning Objectives of the Course:**

- i) To impart basic knowledge and history of polymers.
- ii) To know about the classification and nomenclature of polymer.
- iii) To understand about polymerization process.
- iv) To know the polymer in three dimensions.
- v) To acquainted about the purification of precursors required for polymerization.

**Course Outcomes ( COs) :**

After completion of the course, students will be able to -

- i) Use basic terminology in polymer chemistry
- ii) Identify and explain various intra- and inter- polymeric molecular forces/interactions
- iii) Identify structural levels in polymeric molecules/materials (PM) including amorphous and crystalline nature.
- iv) Explain stereochemistry in PM and consequent structural variations
- v) Identify and distinguish between different grounds for classification of PM, type assignment thereupon and Use Nomenclature systems for naming PMs
- vi) Explain similarities and differences between the dissolution of LMWC and PM based on size and shape differences.
- vii) Explain causes, need and techniques for monomer purification.
- viii) Explain the various polymerization processes with stepwise mechanism and also can predict/speculate the best possible type of the polymerization processes
- ix) Deploy the initiators specific to type of the polymerization processes and monomers.
- x) Write/draw correct steps and chemical structures of intermediates involved in mechanism

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	<b>Structural Features of Polymers:</b> Historical development of polymer chemistry Definitions and Examples of fundamental terms such as Monomers, Oligomers, Telomers, Telomerization, Polymers – Repeating units (Constitutional Repeating Units), Functionality, Pendant Groups. Molecular forces and chemical bonding in Polymers- Primary and secondary bonding, Structural Features of a Polymer, Primary structure – polarity of monomers. Secondary structure – conformation and	10 Hrs

	<p>configuration. Tertiary structure – crystalline and amorphous polymers, Solubility of polymers.</p> <p><b>Stereochemistry</b> – Tacticity - Definition, Isotactic, Syndiotactic, Heterotactic, and Atactic polymers with examples, Geometrical isomerism- cis-tactic and trans-tactic polymers</p> <p><b>Polymer Solutions:</b> Difference between polymers and common chemical compounds (structural and property aspects)</p> <p>Criteria of polymer solubility, The process of polymer dissolution, conformations of dissolved polymer chain, nature of polymer molecules in solution, size and shape of polymer molecules in solution</p>	
II	<p><b>Classification of polymers with examples:</b> based on origin- Natural, Synthetic, and Semi-synthetic; thermal behaviour; Polymerization mechanism; Carother's classification; structure (homopolymers – linear, branched, cross-linked/network, and copolymers – random, alternate, statistical, periodic, block, graft); amorphous and crystalline; application and properties; organic, Hybrid or Organometallic and inorganic polymers</p> <p><b>Nomenclature of polymers:</b> Traditional/ common names, Generic source-based, structure-based Non-IUPAC, IUPAC Structure-based and source-based Nomenclature, nomenclature of co-polymers, linkage-based names, Trade names.</p> <p><b>Monomer purification:</b> Need of monomer purification, Methods of monomer purification</p>	10 Hrs
III	<p><b>Polymerization Processes:</b> Definition, Types/Methods of Polymerization.</p> <p><b>Condensation Polymerization:</b> Introduction, Monomers; Condensation polymerization, Mechanism, interfacial polycondensation.</p> <p><b>Addition Polymerization:</b> Introduction, Types of mechanism of Addition Polymerization</p> <p><b>a. Free radical Polymerization-</b> Initiators –AIBN, peroxides- BPO, TBP, tert-Butyl hydroperoxide, Cumyl hydroperoxide, peroxy acetic acid and per sulphate. Mechanism-Initiation, Propagation, modes of termination, Living Polymer, inhibitors and retarders.</p>	10 Hrs

	<p><b>b. Cationic Polymerization-</b> Initiators- Protic acids, Lewis acids, Mechanism- Initiation, propagation, modes of termination, Living Polymer, ring opening polymerization of cyclic ethers, acetals.</p> <p><b>c. Anionic Polymerization:-</b> Initiators- Hydroxides, Alkoxide, Alkali metals, Metal Hydrides, Organometallic compounds and metal amides. Mechanism- Initiation, Propagation, Modes of termination, living polymer.</p>	
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#### Reference Books

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2. Richard G. Jones, Jaroslav Kahovec, Robert Stepto, Edward S. Wilks, Michael Hess, Tatsuki Kitayama, W. Val Metanowski, The Purple Book, Compendium of Polymer Terminology and Nomenclature, IUPAC Recommendations, Edited by RSC Publishing
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4. F. W. Billmayer, Text book of Polymer Science, 3rd edition, John Wiley & Sons
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11. G. Odian, Principles of polymerization, John Wiley & Sons.
12. G. S. Misra, Introductory Polymer Chemistry, New age International Publishers & Distributors, New Delhi
13. V. K. Ahluwalia & A. Misra, Polymer Science-A Text Book, CRC Press
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15. J. R. Fried, Polymer Science & Technology, Prentice Hall of India Pvt. Ltd, New Delhi
16. Inorganic polymers by G. R. Chatwal, Himalaya Publishing House, 1<sup>st</sup> Edition.
17. D. G. Hundiwale, V. D. Athawale, U. R. Kapadi and V. V. Gite, Experiments in Polymer Science, New Age International Publication.
18. S. M. Ashraf, Sharif Ahmad, Ufana Riaz, A Laboratory Manual of Polymers: Volume I, I K International Publishing House Pvt. Ltd., New Delhi
19. Charles E Carraher, Carraher's Polymer Chemistry: tenth edition, , Jr., CRC Press
20. Paul C. Hiemenz, Timothy P. Lodge, Polymer Chemistry by, CRC Press
21. Dietrich Braun, Harald Cherdron, Matthias Rehahn, Helmut Ritter, Brigitte Voit Polymer Synthesis: Theory and Practice, Springer
22. A. Ravve, Principles of Polymer Chemistry, , Springer
23. Robert O. Ebewele, Polymer Science and Technology, , CRC Press

24. A. D. Ketley, The Stereochemistry of Macromolecules Volume 1, Marcel Dekker Inc., New York
25. Michael B. Smith, Jerry March, March's Advanced Organic Chemistry, Wiley-Interscience.
26. Peter Sykes, A guidebook to Mechanism in Organic Chemistry, Pearson education

### DSC-2 : ( Title of Paper) Lab Course -1

Total Credits : 02

Total Contact Hours : 60 Hrs

Maximum Marks : 50

#### Learning Objectives of the Course:

- i) To aware about the significance of safety measures in laboratory.
- ii) To acquainted about name and classification of various polymers used in polymer articles from day-to-day life and assign identification codes
- iii) To developed separation technique
- iv) To developed the skill for the synthesis of simple polymers in the laboratory.
- v) Use To acquainted about computer applications such as MS Excel: to tabulate, sort and plot relations

#### Course Outcomes ( COs ) :

After completion of the course, students will be able to -

- vi) Ensure safety behaviour while working in polymer chemistry laboratory
- vii) Demonstrate, name and classify various polymers used in polymer articles from day-to-day life and assign identification codes
- viii) Prepare chemical solutions with concentrations expressed in various ways and deploy dilution law for changing concentrations as per need
- ix) Identify most suitable type of distillation for given monomer sample and perform it with utmost skills for best results.
- x) Prepare simple salts, PMs, demonstrate skills to achieve maximum yield with purity and calculate theoretic, practical yield with stoichiometric consideration.
- xi) Use computer applications such as MS Excel : to tabulate, sort and plot relations between variables; chemical structure drawing software.
- xii) Identify solvent and non-solvent for given polymer
- xiii) Demonstrate skills to laminate from polymer solutions

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	1. Hints for Maintaining safety in the Laboratory ( Hazard Symbols, MSDS, etc.) (Compulsory) 2. Demonstration, nomenclature and classification of various polymers used in polymer articles from day-to-day life and their identification codes: PET, PS, PP, LDPE, HDPE, PVC, UPVC, CPVC, Bakelite, NBR, SBR, Natural rubber, Vulcanized rubber, MF resin, Nylons, Terylene, neoprene, Teflon, PU, PMMA, Silicones, etc. (at least 8 polymers)	60 Hrs

	<ol style="list-style-type: none"> <li>3. Identification of synthetic and natural polymers.</li> <li>4. Preparation of solutions of low MW chemical compounds and their dilutions (Express concentration in % w/v, % v/v, Molarity, Normality, etc.) ( liquid and solid samples).</li> <li>5. Fractional Distillation</li> <li>6. Steam Distillation</li> <li>7. Vacuum Distillation</li> <li>8. Monomer Purification. (4 experiments)</li> <li>9. To prepare Hexamethylenediamine Adipate (Nylon salt).</li> <li>10. To prepare Nylon-6,6 by polycondensation of Nylon salt.</li> <li>11. To prepare Nylon-6 by Polycondensation of <math>\epsilon</math>-Aminocaproic Acid in the Melt.</li> <li>12. Application of different software in polymer chemistry- MS Excel, Chemical structure drawing softwares. (4 experiments)</li> <li>13. Preparation of laminates / Polymer Films from solutions. (2 experiments)</li> <li>14. Determination of solvents and non-solvents of polymers. (at least 2 samples)</li> </ol>	
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#### Reference Books

1. Malcolm P. Stevens, Polymer chemistry-An introduction, Oxford Uni. Press.
2. Richard G. Jones, Jaroslav Kahovec, Robert Stepto, Edward S. Wilks, Michael Hess, Tatsuki Kitayama, W. Val Metanomski, The Purple Book, Compendium of Polymer Terminology and Nomenclature, IUPAC Recommendations, Edited by RSC Publishing
3. Encyclopaedia of Physical Science and Technology- Polymers, Academic Press
4. F. W. Billmeyer, Text book of Polymer Science, 3rd edition, John Wiley & Sons
5. V. R. Gowariker, N. V. Viswanathan & J. Sreedhar, Polymer Science, New Age International Publishers.
6. Polymer Chemistry- M. G. Arora and M. Singh, Anmol Publications Pvt. Ltd.
7. P. Bahadur & N. V. Sastry, Principles of Polymer Science, Narosa Publishing House, 2nd Edition, New Delhi.
8. Premamoy Ghosh, Polymer Science & Technology, 3rd edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi.
9. Organic Polymer Chemistry- K J Saunders, Chapman and Hall, London.
10. Physical Chemistry of Macromolecules- D D Deshpande
11. G. Odian, Principles of polymerization, John Wiley & Sons.
12. G. S. Misra, Introductory Polymer Chemistry, New age International Publishers & Distributors, New Delhi
13. V. K. Ahluwalia & A. Misra, Polymer Science-A Text Book, CRC Press
14. S S Dara, Experiments and calculations in engineering chemistry- S. Chand & Company
15. J. R. Fried, Polymer Science & Technology, Prentice Hall of India Pvt. Ltd, New Delhi
16. Inorganic polymers by G. R. Chatwal, Himalaya Publishing House, 1<sup>st</sup> Edition.
17. D. G. Hundiwale, V. D. Athawale, U. R. Kapadi and V. V. Gite, Experiments in Polymer Science, New Age International Publication.

18. S. M. Ashraf, Sharif Ahmad, Ufana Riaz, A Laboratory Manual of Polymers: Volume I, I K International Publishing House Pvt. Ltd., New Delhi
19. Charles E Carraher, Carraher's Polymer Chemistry: tenth edition, , Jr., CRC Press
20. Paul C. Hiemenz, Timothy P. Lodge, Polymer Chemistry by, CRC Press
21. Dietrich Braun, Harald Cherdron, Matthias Rehahn, Helmut Ritter, Brigitte Voit  
Polymer Synthesis: Theory and Practice, Springer
22. A. Ravve, Principles of Polymer Chemistry, , Springer
23. Robert O. Ebewele, Polymer Science and Technology, , CRC Press
24. A. D. Ketley, The Stereochemistry of Macromolecules Volume 1, Marcel Dekker Inc., New York
25. Michael B. Smith, Jerry March, March's Advanced Organic Chemistry, Wiley-Interscience.
26. Peter Sykes, A guidebook to Mechanism in Organic Chemistry, Pearson education

<b>SEC-1 A : ( TITLE OF PAPER) - Water Treatment and Analysis</b>		
Total Credits : 01 (Theory paper)		Total Contact Hours : 15 Hrs
Maximum Marks : 50		
<b>Learning Objectives of the Course:</b>		
<ul style="list-style-type: none"> <li>i) To know the sources of water pollutants</li> <li>ii) To aware about the properties of water</li> <li>iii) Know the difference between industrial effluent and municipal waste</li> <li>iv) Know the quality of drinking water and irrigation water</li> </ul>		
<b>Course Outcomes ( COs) :</b>		
After completion of the course, students will be able to -		
<ul style="list-style-type: none"> <li>a) Resources and properties of water</li> <li>b) Understand the different pollutants</li> <li>c) Understand treatment of domestic and industrial water</li> <li>d) Understand the sources of water pollution</li> </ul>		
<b>Module No.</b>	<b>Topics / actual contents of the syllabus</b>	<b>Contact Hours</b>
<b>I</b>	<b>Study of Water</b> a. Hydrosphere- Water resources. b. Properties of water- color, odor, turbidity, total salt content, total suspended water. b. Water pollution- Definition of water pollution, types of water pollutants, sources of water pollutants, trace element in water, water quality parameters and standards d. Purification of water- Treatment of domestic and industrial water e. Sources of Pollution - Physical, Chemical, Organic & Biological properties of Industrial Wastewater, Difference between industrial; municipal waste waters, Effects of industrial effluents on sewers and Natural water Bodies. <b>Chemistry of Water</b> a. Water Quality Parameters and Standards- Quality of drinking water, Quality of irrigation water, COD, BOD, b. Water Microbiology - TOCE-coli and total bacteria. c. Sewage analysis	<b>15 Hrs</b>
1. D.R. Khanna, R. Bhutiani, Laboratory Manual of Water and Wastewater Analysis, Daya Publishing House, Delhi, 2008 2. R.K. Trivedy Chemical and Biological Methods for Water Pollution Studies, , P.K.Goel,		

Oriental Printing Press, Aligarh, 1986

**SEC-2 A : ( TITLE OF PAPER) - Water Treatment and Analysis**

Total Credits : 01 (Practical paper)

Total Contact Hours : 30 Hrs

Maximum Marks : 50

**Learning Objectives of the Course:**

- i) To know the sources of water pollutants
- ii) To aware about the properties of water
- iii) Know the difference between industrial effluent and municipal waste
- iv) Know the quality of drinking water and irrigation water

**Course Outcomes ( COs) :**

After completion of the course, students will be able to -

- i) Resources and properties of water
- ii) Understand the different pollutants
- iii) Understand treatment of domestic and industrial water
- iv) Understand the sources of water pollution
- v) Carryout experiment for determination of water quality parameters

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	<ol style="list-style-type: none"><li>1. Collection of water samples (Field work)</li><li>2. Determination of total hardness of water</li><li>3. Determination of alkalinity of water</li><li>4. Determination of pH of water</li><li>5. Determination of conductivity of water</li><li>6. Determination of TDS in water.</li><li>7. Determination of Dissolved Oxygen (DO) in water.</li><li>8. Determination of BOD of water</li><li>9. Determination of COD of water</li></ol>	30 Hrs

1. D.R. Khanna, R. Bhutiani, Laboratory Manual of Water and Wastewater Analysis, Daya Publishing House, Delhi, 2008

2. R.K. Trivedy Chemical and Biological Methods for Water Pollution Studies, , P.K.Goel, Oriental Printing Press, Aligarh, 1986

**SEC-1 B : ( TITLE OF PAPER) - IT Application for polymer and polymer processing**

Total Credits : 01 (Theory paper)  
Maximum Marks : 50

Total Contact Hours : 15 Hrs

**Learning Objectives of the Course:**

- a) To developed use of IT applications in Polymer chemistry
- b) Acquaint the use of computer in different processes of polymerization
- c) To train for searching regulation for waste management, commercial database
- d) To train for using Microsoft office application MS word, EXCEL etc

**Course Outcomes ( COs) :**

After completion of the course, students will be able to -

- a) Search websites related to polymers, rules and regulations
- b) Use computer for database search
- c) Apply MSword application for report writing and other records

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	<b>IT applications in Polymer chemistry:</b> Searching websites, use of applications such as MS Office for document preparation, record preparation, database, note keeping, graph plotting, and its application. Materials safety data sheet analysis and report writing. <b>Polymer Processing:</b> Lamination, Extrusion, thermoforming, calendaring, Blow moulding, injection moulding, compression moulding.	15 Hrs
1. V. R. Gowariker, N. V. Viswanathan & J. Sreedhar, Polymer Science, New Age International Publishers.		

**SEC-2 B : ( TITLE OF PAPER) - IT Application for polymer and polymer processing**

Total Credits : 01 (Practical paper)  
Maximum Marks : 50

Total Contact Hours : 30 Hrs

**Learning Objectives of the Course:**

- a) Acquaint the use of computer in different processes of polymerization
- b) To train for searching regulation for waste management, commercial database
- c) To train for using Microsoft office application MSword

**Course Outcomes ( COs) :**

After completion of the course, students will be able to -

- a) Search websites related to polymers, rules and regulations
- b) Use computer for database search
- c) Apply MSword application for report writing and other records

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	<ol style="list-style-type: none"><li>1. Searching websites related to polymers, rules, and regulations related to plastics waste management.</li><li>2. Molecular weight distribution graph plotting.</li><li>3. Commercial polymer database search using a search engine.</li><li>4. Polymer industries survey and report writing using MS Word.</li><li>5. Die casting.</li><li>6. Lamination.</li><li>7. Extrusion.</li><li>8. Thermoforming.</li><li>9. calendaring.</li><li>10. Blow moulding.</li></ol> <p>Injection moulding.</p>	30 Hrs
2. V. R. Gowariker, N. V. Viswanathan & J. Sreedhar, Polymer Science, New Age International Publishers.		

**This course will be available for the students from other faculty**

**GE/ OE -1 : ( TITLE OF PAPER) Plastic Waste Management**

Total Credits : 02

Total Contact Hours : 30 Hrs

Maximum Marks : 50

**Learning Objectives of the Course:**

1

- a) To acquaint the waste management rules 2016
- b) Give knowledge about responsibilities and function of pollution control bodies
- c) To know Extended Producer Responsibility (EPR)
- d) Will know the role of producer
- e) Know the hazards of single use plastic

**Course Outcomes ( COs) :**

- a) After completion of the course, students will be able to -
- b) Implement plastic waste management rules
- c) Understand the role of pollution controlling bodies
- d) Avoid single use plastic.
- e) Develop extended producer responsibility mechanism in their work place

Module No.	Topics / actual contents of the syllabus	Contact Hours
<b>I</b>	<b>Plastic Waste Management Rules, 2016:</b> Timeline of Plastic Waste Management (PWM) Rules; Salient Features of the PWM Rules; Plastic Waste Management (Amendment) Rules, 2022; Stakeholder Mapping; Role of Central Pollution Control Board (CPCB); Role of State Pollution Control Board (SPCB) or Pollution Control Committee (PCC)	<b>10 Hrs</b>
<b>II</b>	<b>Extended Producer Responsibility (EPR) Mechanism:</b> Obligated Entities, Plastic Categories for EPR, Extended Producer Responsibility Mechanism, Plastic Packaging Waste Collection System by PIBOs,	<b>10 Hrs</b>
<b>III</b>	Role of Producer, Importer & Brand Owners (PIBOs); Role of Plastic Waste Processors (PWPs); Comprehensive Action Plan for Effective Compliance of PWM Rules  <b>Single Use Plastic:</b> What is Single Use Plastic (SUP)? Action plan to phase out Single Use Plastic, Examples of replacement of regular plastic by single used plastic	<b>10 Hrs</b>

**Text books/ Reference Books**

1. . Government of India, Pollution Control Board and Delhi Pollution Control Committee, Government of NCT of Delhi and Indian Pollution Control Association, a Delhi

# Semester II

**DSC-3 : ( Title of Paper) BASIC CONEPTS OF POLYMER CHEMISTRY-2**

Total Credits : 02

Total Contact Hours : 30 Hrs

Maximum Marks : 50

**Learning Objectives of the Course:**

- i) To understand the calculate of degree of polymerization and corelate it with molar mass of the polymer and further state its physical significance.
- ii) To understand the principle and Determine number average MM of polymer using various different techniques.
- iii) To know the distinguish between mono- and poly-dispersity of polymer and its implications in polymer synthesis and applications.
- iv) Acquainted to interpret molecular mass distribution curves and calculate polydispersity index to characterize the heterogeneity of polymer
- v) To Know and write correct chemical reactions of polymer molecules through its various functional groups

**Course Outcomes ( COs) :**

After completion of the course, students will be able to -

- vi) Enumerate/calculate of degree of polymerization and corelate it with molar mass of the polymer and further state its physical significance
- vii) Calculate, Express and analyse average degree of polymerization in various forms and state the practical significance each form carries.
- viii) Interpret molecular mass distribution curves and calculate polydispersity index to characterize the heterogeneity of polymer
- ix) Distinguish between mono- and poly-dispersity of polymer and its implications in polymer synthesis and applications.
- x) Asses the correlation between MM and mass of polymer and its mechanical and physical properties
- xi) State/explain the principle and Determine number average MM of polymer using various different techniques
- xii) Know and write correct chemical reactions of polymer molecules through its various functional groups

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	<b>Molecular mass and size of polymers:</b> Degree of polymerization and molecular weight, Practical significance of molecular weight, Average degree of polymerization, Threshold molecular weight, numerical problems. Average Molecular Weight, Average molar	10 Hrs

	<p>mass – Number average, weight average, z-average, Viscosity average molecular weight and molar mass, numerical problems, Molecular mass distribution curve. Polydispersity and polydispersity index of polymers. Examples of monodispersed and polydispersed polymers. Molecular mass &amp; mechanical properties. Size of polymer molecules</p>	
<b>II</b>	<p><b>Determination of Molecular mass of Polymers:</b></p> <p>Absolute and relative methods of molecular mass determination. Determination of No. average molecular mass – End group analysis, Membrane Osmometry, Ebulliometry, cryoscopy &amp; Vapour pressure osmometry, Weight average molecular mass- ultracentrifugation (principle only), Light scattering method, viscosity average molecular mass, Gel permeation (Size-Exclusion) chromatography</p>	<b>10 Hrs</b>
<b>III</b>	<p><b>Polymer reactions:</b></p> <p>Introduction, addition- hydrogenation, hydrohalogenation; substitution (Electrophilic, Nucleophilic and free radical)- Halogenation, Chlorosulfonation of polyethylene, alkylation of Poly(vinyl bromide), SN reactions on PVC, Nitration, Sulphonation, Halogenation, chloromethylation, of aromatic ring, solvolysis - Hydrolysis of Polyoxazoline, PVAc, etc.; isomerization, Cyclization, epoxidation reaction, Vulcanization, condensation reactions of specific groups hydroxyl- Acylation and Xanthation of cellulose, production of Poly(vinyl butyral) from Poly(vinyl alcohol), Poly(vinyl formal); aldehydic, ketonic group (Schmidt and Beckmann rearrangement on a copolymer of ethylene and carbon monoxide) and Schmidt rearrangement on poly(<i>p</i>-acetyl styrene), carboxylic groups, Diazotization, oxidation, and reduction reactions</p>	<b>10 Hrs</b>
<p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>1. Malcolm P. Stevens, Polymer chemistry-An introduction, Oxford Uni. Press.</li> <li>2. Richard G. Jones, Jaroslav Kahovec, Robert Stepto, Edward S. Wilks, Michael Hess, Tatsuki Kitayama, W. Val Metanomski, The Purple Book, Compendium of Polymer Terminology and Nomenclature, IUPAC Recommendations, Edited by RSC Publishing</li> <li>3. Encyclopaedia of Physical Science and Technology- Polymers, Academic Press</li> <li>4. F. W. Billmayer, Text book of Polymer Science, 3rd edition, John Wiley &amp; Sons</li> <li>5. V. R. Gowariker, N. V. Viswanathan &amp; J. Sreedhar, Polymer Science, New Age International Publishers.</li> </ol>		

6. Polymer Chemistry- M. G. Arora and M. Singh, Anmol Publications Pvt. Ltd.
7. P. Bahadur & N. V. Sastry, Principles of Polymer Science, Narosa Publishing House, 2nd Edition, New Delhi.
8. Premamoy Ghosh, Polymer Science & Technology, 3rd edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi.
9. Organic Polymer Chemistry- K J Saunders, Chapman and Hall, London.
10. Physical Chemistry of Macromolecules- D D Deshpande
11. G. Odian, Principles of polymerization, John Wiley & Sons.
12. G. S. Misra, Introductory Polymer Chemistry, New age International Publishers & Distributors, New Delhi
13. V. K. Ahluwalia & A. Misra, Polymer Science-A Text Book, CRC Press
14. S S Dara, Experiments and calculations in engineering chemistry- S. Chand & Company
15. J. R. Fried, Polymer Science & Technology, Prentice Hall of India Pvt. Ltd, New Delhi
16. Inorganic polymers by G. R. Chatwal, Himalaya Publishing House, 1<sup>st</sup> Edition.
17. D. G. Hundiwale, V. D. Athawale, U. R. Kapadi and V. V. Gite, Experiments in Polymer Science, New Age International Publication.
18. S. M. Ashraf, Sharif Ahmad, Ufana Riaz, A Laboratory Manual of Polymers: Volume I, I K International Publishing House Pvt. Ltd., New Delhi
19. Charles E Carraher, Carraher's Polymer Chemistry: tenth edition, , Jr., CRC Press
20. Paul C. Hiemenz, Timothy P. Lodge, Polymer Chemistry by, CRC Press
21. Dietrich Braun, Harald Cherdrion, Matthias Rehahn, Helmut Ritter, Brigitte Voit Polymer Synthesis: Theory and Practice, Springer
22. A. Ravve, Principles of Polymer Chemistry, , Springer
23. Robert O. Ebewele, Polymer Science and Technology, , CRC Press
24. A. D. Ketley, The Stereochemistry of Macromolecules Volume 1, Marcel Dekker Inc., New York
25. Michael B. Smith, Jerry March, March's Advanced Organic Chemistry, Wiley-Interscience.
26. Peter Sykes, A guidebook to Mechanism in Organic Chemistry, Pearson education

### DSC-4 : ( Title of Paper) Lab course-2

Total Credits : 02  
Maximum Marks : 50

Total Contact Hours : 60 Hrs

#### Learning Objectives of the Course:

- i) To aware safety behavior while working in polymer chemistry laboratory
- ii) To use various method to calculate MW / MW average with accuracy and precision
- iii) To developed skill to increase the yield of polymers.
- iv) To acquainted about the synthesis of various polymer.
- v) To developed the skill of understand and drawing of mechanism of polymerization.
- vi) To train for the use of MS excel software to plot and chemical structure drawing software to draw mechanism of reactions of polymers

#### Course Outcomes ( COs) :

After completion of the course, students will be able to -

- vii) Ensure safety behaviour while working in polymer chemistry laboratory
- viii) Apply viscometry, end group analysis method, Fractional precipitation, Partial dissolution technique, Gel permeation chromatography principles to calculate MW / MW average with accuracy and precision
- ix) Demonstrate the reactions of polymers, skills to maximize yield.
- x) Efficiently use MS excel software to plot and chemical structure drawing software to draw mechanism of reactions of polymers

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	<ol style="list-style-type: none"><li>1. Hints for Maintaining safety in the Laboratory ( Hazard Symbols, MSDS, etc.) (Compulsory)</li><li>2. To Determine the Molecular Weight by Viscometry (4 samples).</li><li>3. To Determine the Molecular Weight by End Group Analysis (3 samples).</li><li>4. To Determine the size distribution of polymers by Dynamic Light Scattering (DLS).</li><li>5. To determine Molecular weight distribution and Molecular weight averages by fractionation: Fractional precipitation / Partial dissolution technique / Gel permeation chromatography.</li></ol>	60 Hrs

	6. To Prepare Polyvinyl Alcohol from Polyvinyl Acetate. 7. To prepare Cation Exchanger by Sulfonation of Crosslinked Polystyrene 8. To prepare Poly(vinylbutyral). 9. Acetylation of PVA / Cellulose. 10. To prepare sodium carboxymethylcellulose. 11. Xanthation of cellulose. 12. Preparation of Linear Poly (Ethyleneimine) by Hydrolysis of Polyoxazoline. 13. Hydrolysis of a Copolymer of Styrene and Maleic Anhydride. 14. Application of different software in polymer chemistry- (6 experiments) a. Graph plotting using Excel/ Origin Lab. etc. Drawing Mechanism of polymerization reactions using chemical structure drawing softwares	
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#### REFERENCE BOOKS

1. Malcolm P. Stevens, Polymer chemistry-An introduction, Oxford Uni. Press.
2. Richard G. Jones, Jaroslav Kahovec, Robert Stepto, Edward S. Wilks, Michael Hess, Tatsuki Kitayama, W. Val Metanomski, The Purple Book, Compendium of Polymer Terminology and Nomenclature, IUPAC Recommendations, Edited by RSC Publishing
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4. F. W. Billmeyer, Text book of Polymer Science, 3rd edition, John Wiley & Sons
5. V. R. Gowariker, N. V. Viswanathan & J. Sreedhar, Polymer Science, New Age International Publishers.
6. Polymer Chemistry- M. G. Arora and M. Singh, Anmol Publications Pvt. Ltd.
7. P. Bahadur & N. V. Sastry, Principles of Polymer Science, Narosa Publishing House, 2nd Edition, New Delhi.
8. Premamoy Ghosh, Polymer Science & Technology, 3rd edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi.
9. Organic Polymer Chemistry- K J Saunders, Chapman and Hall, London.
10. Physical Chemistry of Macromolecules- D D Deshpande
11. G. Odian, Principles of polymerization, John Wiley & Sons.
12. G. S. Misra, Introductory Polymer Chemistry, New age International Publishers & Distributors, New Delhi
13. V. K. Ahluwalia & A. Misra, Polymer Science-A Text Book, CRC Press
14. S S Dara, Experiments and calculations in engineering chemistry- S. Chand & Company
15. J. R. Fried, Polymer Science & Technology, Prentice Hall of India Pvt. Ltd, New Delhi
16. Inorganic polymers by G. R. Chatwal, Himalaya Publishing House, 1<sup>st</sup> Edition.
17. D. G. Hundiwale, V. D. Athawale, U. R. Kapadi and V. V. Gite, Experiments in Polymer Science, New Age International Publication.

18. S. M. Ashraf, Sharif Ahmad, Ufana Riaz, A Laboratory Manual of Polymers: Volume I, I K International Publishing House Pvt. Ltd., New Delhi
19. Charles E Carraher, Carraher's Polymer Chemistry: tenth edition, , Jr., CRC Press
20. Paul C. Hiemenz, Timothy P. Lodge, Polymer Chemistry by, CRC Press
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Polymer Synthesis: Theory and Practice, Springer
22. A. Ravve, Principles of Polymer Chemistry, , Springer
23. Robert O. Ebewele, Polymer Science and Technology, , CRC Press
24. A. D. Ketley, The Stereochemistry of Macromolecules Volume 1, Marcel Dekker Inc., New York
25. Michael B. Smith, Jerry March, March's Advanced Organic Chemistry, Wiley-Interscience.
26. Peter Sykes, A guidebook to Mechanism in Organic Chemistry, Pearson education

**VSC-1 A : ( TITLE OF PAPER) - Recycling of Polymer and Waste Management – 1**

Total Credits : 01 (Theory paper)  
Maximum Marks : 50

Total Contact Hours : 15 Hrs

**Learning Objectives of the Course:**

- I. To know about different plastic waste.
- II. To acquainted about different sources of polymer waste
- III. To developed skills about the recycling of polymer to protect the environment.
- IV. To educate about used of 4 R's approach for thermoplastic waste management and recycling of thermoset polymer.
- V. To know about the economics of plastic waste in India

**Course Outcomes ( COs) :**

After completion of the course, students will be able to –

- I. Understand different types of plastic waste
- II. Know various sources of plastic waste.
- III. Understand the separation techniques for polymer separation from waste.
- IV. Understand about recycling of polymers
- V. Understand the economics of plastic waste in India

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	<b>Unit 1.</b> Definition of plastic wastes, Industrial Plastic Waste, Postconsumer Plastic Waste, Nuisance Plastic, Scrap Plastic; Status of plastic waste in India, Economic and environmental impact of Plastic Waste.  Sources of waste – postconsumer, municipal and industrial waste  Separation using recycling codes  Separation techniques (density - float sink and froth floatation methods, optical, spectroscopic, sorting by melting temperature etc.). Thermoplastic waste management: 4 R's approach (reduce, reuse, recycle (mechanical and chemical), recover).  Recycling classification: primary, secondary, tertiary, & quaternary recycling with examples.  Recycling of Thermosets – reclaiming of rubber –pyrolysis, depolymerization of scrap rubber, tyre retreading, uses of recycled rubber	15 Hrs

1. Rubber and Plastic Waste: Recycling, Reuse and Future Demand by R. Chandra and A. Adab, CBS Publisher (2004).
2. Plastic Waste by Jacob Leidner, Marcel Dekker
3. Medical, Municipal and Plastic Waste Management Handbook by NIIR Board of Consultant and Engineers, National Institute of Industrial Research (2007).
4. Modern Plastics Handbook by Harper, McGraw-Hill
5. Polymer Recycling by J. Scheirs, John Wiley & Sons (1998).
6. Handbook of Rubber Technology by S. Blow, Hanser Gardner (2000).
7. Recycling and Recovery of Plastics by J. E. Bandrup, Hanser Gardner (1996).
8. Introduction to plastics recycling by V. Goodship, Rapra (2007).

**VSC-2 A : ( TITLE OF PAPER) - Recycling of polymers and Waste Management – 1**

Total Credits : 01 (Practical paper)  
Maximum Marks : 50

Total Contact Hours : 30 Hrs

**Learning Objectives of the Course:** Can Acquire knowledge of basic concepts and techniques of soap and detergent industry.

- I. To impart hands on training of recycling of waste collected from environment.
- II. To acquainted about the different sources of plastic waste.
- III. To study the composting of natural polymer.
- IV. To study various pyrolysis reactors.
- V. To convert polyester waste in to plasticizer.
- VI. To developed skill for recycling by chemical modification of plastic waste

**Course Outcomes ( COs) :**

After completion of the course, students will be able to –

- VII. Understand recycling of waste collected from environment.
- VIII. Know different sources of plastic waste.
- IX. Aware about the composting of natural polymer
- X. Understand the conversion of polyester waste in to plasticizer
- XI. Understand various pyrolysis reactors

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	<ol style="list-style-type: none"><li>1. Primary recycling of various waste collected from environment.</li><li>2. Secondary recycling of MSW by in</li><li>3. incorporating and blending the recyclable waste with virgin polymers.</li><li>4. To study various sources of plastic waste.</li><li>5. To study Composting of natural polymers.</li><li>6. Preparation of plasticizer from polyester waste.</li><li>7. Preparation of curing hardness for epoxy from polyester waste.</li><li>8. Preparation of reclaim from tyre waste</li><li>9. To study various pyrolysis reactors.</li><li>10. To study recycling by chemical modification of plastic waste</li></ol>	30 Hrs
1. Rubber and Plastic Waste: Recycling, Reuse and Future Demand by R. Chandra and A. Adab, CBS Publisher (2004).		

2. Plastic Waste by Jacob Leidner, Marcel Dekker
3. Medical, Municipal and Plastic Waste Management Handbook by NIIR Board of Consultant and Engineers, National Institute of Industrial Research (2007).
9. Modern Plastics Handbook by Harper, McGraw-Hill
10. Polymer Recycling by J. Scheirs, John Wiley & Sons (1998).
11. Handbook of Rubber Technology by S. Blow, Hanser Gardner (2000).
12. Recycling and Recovery of Plastics by J. E. Bandrup, Hanser Gardner (1996).
13. Introduction to plastics recycling by V. Goodship, Rapra (2007).

**VSC-1 B : ( TITLE OF PAPER) - Soap and detergents**

Total Credits : 01 (Theory paper)

Total Contact Hours : 15 Hrs

Maximum Marks : 50

**Learning Objectives of the Course:**

To aware the different types of cleaning agents

To aware different methods used of preparation of soaps detergents and shampoos

To know the different parameters for purity of soaps, detergents and shampoos

To know the techniques for checking quality and purity of samples

**Course Outcomes ( COs) :**

After completion of the course, students will be able to -

**CO1:** Can gain the information about soaps, detergents and shampoos.**CO2:** Can Acquire knowledge of basic concepts and techniques of soap and detergent industry.**CO3:** Get hands training of analysis of soaps and detergents.**CO4:** Aware about environmental aspects of detergents.**CO5:** Development Skill for detergent, liquid soap and laundry soap making

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	<b>Soaps and Detergents</b> <b>Soap</b> -Introduction. Types of soaps - Toilet soaps, washing soaps. Liquid soap. TFM and grades of soaps. Bathing bars. Saponification process, cleansing action of soap. <b>Detergents</b> -Introduction. Types of detergents - anionic, cationic, non-ionic and amphoteric detergents. Common detergent additives. Enzymes used in commercial detergents. Comparison between soaps and detergents. Environmental aspects. <b>Shampoos</b> Manufacture of SLS and SLES. Ingredients. Functions. Different kinds of shampoos – antidandruff, anti-lice, herbal and baby shampoos. Manufacture of conditioners	15 Hrs

Reference books

1. Handbook on Soaps- Detergents & Acid Slurry 2nd Edition by Niir Board
2. Ajay Kr. Gupta, Handbook on Soaps, Detergents & Acid Slurry , 3rd revised edition; NIIR Board publication. ISBN: 9789381039472
3. P. K. Chattopadhyay, Modern Technology of Soaps, Detergents & Toiletries (with Formulae & Project Profiles) 4th Revised Edition, NIIR Board publication; ISBN: 9789381039700
4. H. Panda, Herbal Soaps & Detergents Handbook, NIIR Board publication; ISBN: 978938103900.
5. I. Ash, M. Ash, Formulary of Detergents and other Cleaning Agents, Chemical Publishing, 1999. 3.
6. H. Butler, Poucher's Perfumes, Cosmetics and Soaps, 10th Edn., Springer, 2000)

**VSC-2 B : ( TITLE OF PAPER) - Soap and detergents**

Total Credits : 01 (Practical paper)

Total Contact Hours : 30 Hrs

Maximum Marks : 50

**Learning Objectives of the Course:**

- a) To aware the different types of cleaning agents
- b) To aware different methods used of preparation of soaps detergents and shampoos
- c) To know the different parameters for purity of soaps, detergents and shampoos
- d) To know the techniques for checking quality and purity of samples

**Course Outcomes ( COs) :**

After completion of the course, students will be able to -  
Can gain the information about soaps, detergents and shampoos.

**CO2:** Can Acquire knowledge of basic concepts and techniques of soap and detergent industry.

**CO3:** Get hands training of analysis of soaps and detergents.

**CO4:** Aware about environmental aspects of detergents.

**CO5:** Development Skill for detergent, liquid soap and laundry soap making

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	<ol style="list-style-type: none"><li>i) Determine the pH of shampoos, soaps and detergent.</li><li>ii) Determination of physico-chemical characteristics of oil and fats</li><li>iii) Moisture content</li><li>iv) Acid value</li><li>v) Iodine value</li><li>vi) Saponification reaction and Saponification value</li><li>vii) Synthesis of soap</li><li>viii) Manufacture of liquid soap</li><li>ix) Manufacture of laundry soap.</li><li>x) Determination of free caustic alkali and combined alkali in soap.</li><li>xi) Estimation of rosin in Soap</li></ol>	30 Hrs

**Reference books**

1. Handbook on Soaps- Detergents & Acid Slurry 2nd Edition by Niir Board

2. Ajay Kr. Gupta, Handbook on Soaps, Detergents & Acid Slurry , 3rd revised edition; NIIR Board publication. ISBN: 9789381039472
3. P. K. Chattopadhyay, Modern Technology of Soaps, Detergents & Toiletries (with Formulae & Project Profiles) 4th Revised Edition, NIIR Board publication; ISBN: 9789381039700
4. H. Panda, Herbal Soaps & Detergents Handbook, NIIR Board publication; ISBN: 978938103900.
5. I. Ash, M. Ash, Formulary of Detergents and other Cleaning Agents, Chemical Publishing, 1999. 3.
6. H. Butler, Poucher's Perfumes, Cosmetics and Soaps, 10th Edn., Springer, 2000)

**This course will be available for the students from other faculty**

**GE/OE-2 : ( Title of Paper) Polymer: Basic Concepts, Applications and Its Socio-environmental Impact**

Total Credits : 02

Total Contact Hours : 30 Hrs

Maximum Marks : 50

**Learning Objectives of the Course:**

- a) To acquaint the types of polymers
- b) To acquaint the methods of preparation of polymers
- c) To know the applications of polymers in different field
- d) To understand the impact of waste polymers on environment and their management

**Course Outcomes ( COs) :**

After completion of the course, students will be able to -

- a) Use different techniques and methods of preparing polymers
- b) Identify types of polymers and apply for particular purpose
- c) Manage the waste polymers to decrease pollution
- d) Apply rules and regulation for use of polymers

Module No.	Topics / actual contents of the syllabus	Contact Hours
I	<p><b>Fundamental Terminology and Processes in polymer and polymerization:</b></p> <p>History of Polymers, Polymerization Techniques and Mechanisms, Types of Polymer Synthesis, Polymer Structure, Thermal, Mechanical Properties of polymer</p> <p><b>Applications of Polymers -I:</b></p> <p>in</p> <ul style="list-style-type: none"> <li>• household products</li> <li>• packaging materials</li> <li>• textiles and clothing</li> </ul> <p>construction materials</p>	10 Hrs
II	<p><b>Applications of Polymers - II:</b></p> <p>in</p> <ul style="list-style-type: none"> <li>• Paint and Dye trapping industry</li> </ul>	10 Hrs

	<ul style="list-style-type: none"> <li>• automotive industry</li> <li>• Electronics and Electrical Devices</li> </ul> <p>Medicine and Surgery</p>	
<b>III</b>	<p><b>Environmental and Societal Impacts of Polymers</b></p> <p><b>Polymer Recycling and Plastic Waste Management:</b></p> <p>Plastic Waste: Definition, Global Scenario, sources, Management Practices, issues and challenges. Polymer Recycling and Sustainability, Regulations and Policies Related to Polymer Usage.</p>	<b>10 Hrs</b>

**Reference Books**

1. Textbook: "Principles of Polymer Chemistry" by Paul J. Flory
2. "Principles of Polymerization" by George Odian - This book provides a comprehensive introduction to the principles and mechanisms of polymerization, covering both addition and condensation polymerization techniques.
3. "Introduction to Polymers" by Robert J. Young and Peter A. Lovell - This textbook offers a thorough overview of polymer science, including the molecular structure, properties, synthesis methods, and applications of polymers.
4. "Polymer Chemistry: An Introduction" by Malcolm P. Stevens - This book covers various aspects of polymer chemistry, including polymerization techniques, mechanisms, structure-property relationships, and copolymerization" Introduction to Polymer Chemistry" by Charles E. Carraher Jr.
5. "Polymer Science and Technology" by Joel R. Fried
6. "Understanding Polymers: An Introduction to Polymer Chemistry" by Iwao Teraoka
7. Soroka, W. (2002). Fundamentals of Packaging Technology. IoPP.
8. Yam, K. L., & Papadakis, S. E. (Eds.). (2014). Food Packaging: Materials and Machines. CRC Press.
9. Textile Institute. (2013). Handbook of Textile and Industrial Dyeing: Principles, Processes, and Types of Dyes. Elsevier.
10. Melliland Textilberichte International. (2011). Man-Made Fibers: Their Production, Properties and Applications. Springer
11. Ullmann's Encyclopedia of Industrial Chemistry. (2000). Wiley-VCH.
12. Kim, J. K., & Pal, K. (Eds.). (2016). Handbook of Polymer Nanocomposites: Processing, Performance and Application. Springer.
13. Friedrich, K., & Karger-Kocsis, J. (Eds.). (2012). Composite Materials: Functional Materials for Modern Technologies. Springer.
14. Pohl, G. (2001). Automotive Plastics & Composites. Hanser Publishers
15. Richardson, M., & Textile Institute. (2013). Polymer-Modified Textile Materials. Elsevier.
16. Cook, W. D. (2013). Handbook of Textile Fibre Structure (Volume 1): Fundamentals and Manufactured Polymer Fibres. Elsevier.
17. Rajan, T. P. D. (2013). Introduction to Nanoscience and Nanotechnology. PHI Learning Pvt. Ltd.

18. Kao, K. C. (2004). Dielectric Phenomena in Solids: With Emphasis on Physical Concepts of Electronic Processes. Elsevier.
19. Ratner, B. D., Hoffman, A. S., Schoen, F. J., & Lemons, J. E. (Eds.). (2004). Biomaterials Science: An Introduction to Materials in Medicine. Academic Press.
20. Peppas, N. A., & Langer, R. (2016). "New challenges in biomaterials." Science, 368(3922), 58-64.
21. Williams, D. F. (2008). "On the mechanisms of biocompatibility." Biomaterials, 29(20), 2941-2953.
22. Park, K. (2019). "Biomaterials for drug delivery and tissue engineering." Journal of Controlled Release, 219, 1-2

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