

DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY**CIRCULAR NO.SU./B.Sc.CBC & GS/11/2022**

It is hereby inform to all concerned that, on the recommendation of Faculty of Science & Technology Meeting dated 24.08.2022, **the Academic Council at its meeting held on 29 August 2022 has accepted the following Syllabi of B.Sc. Degree under the Choice Based Credit & Grading System along with Rules and Regulation** as appended herewith:-

1.	B.Sc.Computer Science (Optional)	Ist and IInd semester
2.	B.Sc.Computer Application (Optional)	Ist and IInd semester
3.	B.Sc.Computer Application (Degree)	Ist and IInd semester
4.	B.Sc.Computer Science (Degree)	Ist and IInd semester
5.	B.Sc.Horticulture (Optional)	Ist to VIth semester
6.	B.Sc.Botany (Optional)	Ist to VIth semester
7.	B.Sc. Agrochemical & fertilizer (Optional)	Ist to VIth semester
8.	B.Sc.Home Science (Optional)	Ist and IInd semester
9.	B.Sc.Automobile Technology (Degree)	Ist and IInd semester
10.	B.Sc.Workshop Technology (Degree)	Ist and IInd semester
11.	B.Sc.Refrigeration and Air Conditioning (Degree)	Ist and IInd semester
12.	B.Sc.Environmental Science (Optional)	Ist and IInd semester
13.	B.Sc.Biotechnology (Degree)	Ist and IInd semester
14.	B.Sc.Biotechnology (Optional)	Ist and IInd semester
15.	B.Sc.Dairy Sci.& Tech (Optional)	Ist and IInd semester
16.	B.Sc.Zoology (Optional)	Ist to VIth semester
17.	B.Sc.Polymer Chemistry (Optional)	Ist and IInd semester
18.	B.Sc.Fisheries Science (Optional)	Ist and IInd semester
19.	B.Sc.Instrumentation Practice (Optional)	Ist semester
20.	B.Sc.Biochemistry (Optional)	Ist and IInd semester
21.	B.Sc.Non Conventional & Conventional Energy (Degree)	Ist and IInd semester

This is effective from the Academic Year 2022-23 and onwards.

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

University Campus,
Aurangabad-431 004.

Ref.No. SU/B.Sc./2022/ 8428-35

Date:-29.08.2022.

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[Signature]
**Deputy Registrar,
Academic Section**

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Copy forwarded with compliments to :-

- 1] **The Principal, concerned affiliated College,**
Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.
- 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,
- 2] The Section Officer,[B.Sc.Unit] Examination Branch,
- 3] The Programmer [Computer Unit-1] Examinations,
- 4] The Programmer [Computer Unit-2] Examinations,
- 5] The In-charge, [E-Suvidha Kendra],
Rajarshi Shahu Maharaj Examination Branch,
- 6] The Public Relation Officer,
- 7] The Record Keeper,

JS*29082022/-

**Dr. BABASAHEB AMBEDKAR MARATHWADA
UNIVERSITY, AURANGABAD**



SYLLABUS

B.Sc. Polymer Chemistry

(Semester I & II)

Choice Based Credit and Grading System

Dr. B. H. Sapat
Dr. B. H. Sapat

Effective From June 2022

Choice Based Credit and Grading System (CBCS) Curriculum

For

Faculty of Science and Technology

Course Structure and Scheme of Examination

B.Sc. Three Year Under Graduate Degree Program for Polymer Chemistry with effect from June 2022

Semester I:

	Course Code	Course Title	Teaching time/week	Credits	Scheme of Examination		
					Max. Marks	CIA	UA
Optional 1 (DSC-1A) Core Courses	PCH-101	Basic Concepts in Polymer Chemistry-I	03	02	50	10	40
	PCH-102	Basic Concepts in Polymer Chemistry-II	03	02	50	10	40
	PCHL-103	Lab Course - 1	04	1.5	50	10	40

Total Credits for Semester I: 5.5 (Theory: 04; Laboratory: 1.5).

Semester II:

	Course Code	Course Title	Teaching time/week	Credits	Scheme of Examination		
					Max. Marks	CIA	UA
Optional 1 (DSC-1B) Core Courses	PCH-201	Natural Polymers	03	02	50	10	40
	PCH-202	Raw materials of polymers and Polymerization reactions	03	02	50	10	40
	PCHL-203	Lab Course - 2	04	1.5	50	10	40

Total Credits for Semester II: 5.5 (Theory: 04; Laboratory: 1.5).

Semester III:

	Course Code	Course Title	Teaching time/week	Credits	Scheme of Examination			
					Max. Marks	CIA	UA	Min Marks
Optional 1 (DSC-1C)	PCH-301	Core course 1	3	2	50	10	40	20
	PCH-302	Core course 2	3	2	50	10	40	20
Core Courses	PCHL-303	Lab course 3	4	1.5	50	10	40	20
	PCHL-304	Lab course 4	4	1.5	50	10	40	20

Total Credits for Semester III: 07 (Theory: 04; Laboratory: 03).

Semester IV:

	Course Code	Course Title	Teaching time/week	Credits	Scheme of Examination			
					Max. Marks	CIA	UA	Min Marks
Optional 1 (DSC-1D)	PCH-401	Core course 1	3	2	50	10	40	20
	PCH-402	Core course 2	3	2	50	10	40	20
Core Courses	PCHL-403	Lab course 5	4	1.5	50	10	40	20
	PCHL-404	Lab course 6	4	1.5	50	10	40	20

Total Credits for Semester IV: 07 (Theory: 04; Laboratory: 03).

Semester V:

	Course Code	Course Title	Teaching time/week	Credits	Scheme of Examination			
					Max. Marks	CIA	UA	Min Marks
Optional 1 (DSC-1E)	PCH-501	Core course 1	3	2	50	10	40	20
	PCH-502	Core course 2	3	2	50	10	40	20
Core Courses	PCHL-503	Lab course 7	4	1.5	50	10	40	20
	PCHL-504	Lab course 8	4	1.5	50	10	40	20

Total Credits for Semester V: 07 (Theory: 04; Laboratory: 03).

Semester VI:

	Course Code	Course Title	Teaching time/week	Credits	Scheme of Examination			
					Max. Marks	CIA	UA	Min Marks
Optional 1 (DSC-1F)	PCH-601	Core course 1	3	2	50	10	40	20
	PCH-602	Core course 2	3	2	50	10	40	20
Core Courses	PCHL-603	Lab course 9	4	1.5	50	10	40	20
	PCHL-604	Lab course 10	4	1.5	50	10	40	20

Total Credits for Semester VI: 07 (Theory: 04; Laboratory: 03).

Total Credits for three years: Sem. I (5.5) + Sem. II (5.5) + Sem. III (07) + Sem. IV (07) + Sem. V (07) + Sem. VI (07) = 39 Credits

COURSE OBJECTIVES:

The objectives of the course are:

1. To introduce the specialized subject of the chemistry of polymers,
2. To understand the terms – Feedstocks, Petrochemicals, Petroleum refining, monomer, polymer, polymerization, mechanisms of the polymerization reactions
3. To familiarize the students with the types of polymers, structures of polymers, the significance and determination of their molecular mass.
4. To understand in detail the natural polymers and their modifications.

COURSE SYNOPSIS:

Basic principles of polymer chemistry, petrochemicals, natural polymers, inorganic polymers, molecular mass & size, mechanism of free radical, ionic, condensation & Coordination polymerization, Polymer reactions.

Important Notes:

Nomenclature: PCH – Polymer chemistry; PCHL – Polymer chemistry practical, DSC – Discipline specific core course; UA – University assessment; CIA – Continuous Internal evaluation.

Assessment: 80% for University Assessment (semester end examination) & 20% for continuous internal assessment.

Continuous internal assessment (CIA): Theory (10 marks) – internal test 05 marks (two internal tests of 05 marks each and average of the two test will be considered) and 05 marks for assignment/tutorials; **Practical (10 marks)** – 07 marks for internal practical examination and 03 marks for record book/ submission of collection and field survey report and excursion report.

Practical examination: Annual examination.

COURSE CONTENT: Polymer Chemistry B.Sc. First Year

(Semester-I)

Paper-I: (PCH-101) Basic Concepts in Polymer Chemistry-I		2 Credits (45 Hrs)
Unit No.	Content	Hrs
Unit 1:	Introduction to Polymer Chemistry: Historical development of polymer chemistry, 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 configuration. Tertiary structure – crystalline and amorphous polymers, Solubility of polymers. Difference between polymers and common chemical compounds (structural and property aspects)	12
Unit 2:	Classification of Polymers: Classification of polymers with examples– based on origin- Natural, Synthetic and Semi-synthetic; thermal response; Polymerization mechanism; Carother's classification; structure (homopolymers – linear, branched, cross-linked/network, and copolymers – random, alternate, statistical, periodic, block, graft); application and properties; organic, Hybrid or Organometallic and inorganic polymers.	10
Unit 3:	Nomenclature of polymers: – 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.	10
Unit 4:	Stereochemistry of polymers: Stereoisomerism Isomerism- Introduction, Types of isomers Basics of stereochemistry of common organic compounds- Fischer, Newman, Sawhorse and wedge projections, Bond angle and torsion angle, Conformations of butane, propane, etc., Symmetry elements, Optical Activity, Chirality, Stereogenic Centre, Enantiomers, Chiral and Achiral compounds with two stereogenic centres, CIP rules, Enantiomers, Diastereomers, erythro and threo isomers, meso compounds, racemic mixture, Geometrical isomers. Structural isomerism in polymers with examples. Some examples of polymer possessing stereo-centers (give their structures)	13

Paper-II: (PCH-102) Basic Concepts in Polymer Chemistry – II**2 Credits (45 Hrs)**

Unit 1:	Molecular mass and size of polymers: 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 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 & mechanical properties. Size of polymer molecules.	10
Unit 2:	Determination of Molecular mass of Polymers: Absolute and relative methods of molecular mass determination. Determination of No. average molecular mass – End group analysis, Membrane Osmometry, Ebulliometry, cryoscopy & Vapour pressure osmometry, Weight average molecular mass- ultracentrifugation (principle only), Light scattering method (No experimental details expected), viscosity average molecular mass, Gel permeation (Size-Exclusion) chromatography.	15
Unit 3:	Polymer reactions: Introduction, addition- hydrogenation, hydrohalogenation; substitution (Electrophilic, Nucleophilic and free radical)- Halogenation, Chlorosulphonation of polyethylene, alkylation of Poly(vinyl bromide), SN reactions on PVC, Nitration, Sulphonation, Halogenation, chloromethylation, of aromatic ring, solvolysis; isomerization, Cyclization, epoxidation reaction, Vulcanization, condensation reactions of specific groups hydroxyl- Acetylation and Xanthation of cellulose.	10
Unit 4:	Polymerization techniques: Introduction, Homopolymerization and heteropolymerization, Bulk polymerization, Solution polymerization, Suspension polymerization, Emulsion polymerization, Melt Polymerization, Interfacial condensation polymerization and their Salient features and disadvantages.	10

Paper-III: (PCH-103) Lab Course-I

1.5 Credits (45 Hrs)

Note: Attempt at least 6 of the following

1. Hints for Maintaining safety in the Laboratory (Compulsory)
2. Determination of hydroxyl value of a polymer/resin (2 samples)
3. Determination of iodine value of polymer/resin (2 samples)
4. Determination of saponification value of polyesters/alkyd resins/oils (3 samples)
5. Determination of carbonyl value of polymer/resin (2 samples).
6. Determination of amine value of polymer/resin (2 samples).
7. Determination of molecular weight by viscometry analysis (2 samples).
8. Determination of molecular weight by end group analysis (2 samples).
9. To prepare poly vinyl alcohol from poly vinyl acetate.
10. Preparation of Hexamethylenediammonium Adipate (Nylon salt).
11. Application of different softwares in polymer chemistry- (3 experiments)
 - a) Graph plotting & Modelling using Excel/Schrodinger/OriginLab/Material Studio etc.
 - b) Drawing structures of different polymers (at least 5 polymer structure/ repeating unit- chain, branched, ladder, spiro and cross-linked, representative structures of polysaccharides) using chemistry softwares.

Semester- II

Paper-IV: (PCH-201) Natural Polymers		2 Credits (45 Hrs)
Unit 1:	Polysaccharides: Introduction, Monosaccharides- Pentoses and Hexoses- Fischer projection, Furanose and Pyranose forms, Homopolysaccharides and Heteropolysaccharides- examples. Sources, structure, properties and applications of Cellulose, Starch- Amylose and Amylopectin, Glycogen, Chitin, Chitosan, Hemicelluloses- Introduction, Xylans, Xyloglucans, Galactans, Arabinan, Pectins, Mannans, Glucomannans Hydrolysis of polysaccharides, Preparation of furfural and furan from pentosan. Regenerated cellulose- Viscose process, Cuprammonium process and using N-Methylmorpholine-N-oxide.	12
Unit 2:	Modifications of Cellulose - Preparation, Properties and applications- Etherification- Methyl Cellulose, Ethyl Cellulose, sodium Carboxymethylcellulose, Hydroxyethylcellulose, carboxymethylhydroxyethylcellulose, Hydroxypropylcellulose, Ethylhydroxyethylcellulose, Cyanoethylcellulose; Inorganic esters- Cellulose nitrate, Cellulose phosphate; Esterification- Cellulose acetate, Cellulose acetate propionate, Cellulose acetate butyrate; Starch and dextrins - Preparation, Properties and Applications. Starch in biodegradable blends. Miscellaneous polysaccharides- Alginic acid, gellan gum, carrageenan, Agar / agarose, Dextrans, Xanthan, etc. - Sources, properties and applications.	13
Unit 3:	Polyesters, Resins: Introduction, Shellac, Lignin, polyalkanoates – Introduction, Sources, structure, properties and applications.	12
Unit 4:	Proteins: Introduction, Common Amino acids found in proteins, Primary, Secondary, Tertiary and Quaternary Structure of proteins with examples, Denaturation, Enzymes, Casein, Wool, Silk, Synthetic methods for the preparation of polypeptides. Chemical Modifications of proteins- Galalith (casein plastic), gelatin	08

Paper-V: (PCH-202) Raw materials of polymers and Polymerization reactions**2 Credits (45 Hrs)**

Unit 1:	Raw materials of polymers- Petroleum and petrochemicals Oil, natural gas, coal- capabilities and limitations, General consideration of petrochemicals- Introduction, Definition, Categorization of petrochemicals on the basis of chemical structure, Important Petrochemicals- monomers, solvents (structure and functional groups only)- Ethylene, Propylene, Styrene, Butylenes, Dienes- Butadiene, Isoprene, phthalic acid, terephthalic acid, phenols, polyols, amino compounds, alcohols, toluene, xylene, acetone, chloromethanes, An overview of petroleum refining, desalting, distillation, cracking, and their types;	10
Unit 2:	Synthesis of important monomers- Ethylene oxide, propylene oxide, Ethylene glycol, propylene glycol, Acetaldehyde, Vinyl chloride, Vinyl fluoride, Vinyl acetate, Acrylic acid, acrylate ester, methacrylic acid, methacrylate ester, Acrylonitrile, methacrylonitrile, tetrafluoroethylene.	10
Unit 3:	Condensation polymerization: Introduction, Monomers; Condensation polymerization, Mechanism, interfacial polycondensation, ladder polymers, Spiro polymers.	10
Unit 4:	Chain Polymerization: Introduction a) Free radical Polymerization- 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, ring opening polymerization of vinylcyclopropane derivatives. b) Cationic Polymerization- Initiators- Protic acids, Lewis acids, Mechanism- Initiation, propagation, modes of termination, Living Polymer, ring opening polymerization cyclic ethers, acetals. Anionic Polymerization:- Initiators- Hydroxides, Alkoxide, Alkali metals, Metal Hydrides, Organometallic compounds and metal amides. Mechanism- Initiation, Propagation, Modes of termination, living polymer, ring opening polymerization of lactam, lactone.	15

Paper-VI: (PCHL-203) Lab Course-II

1.5 Credits (45 Hrs)

Note: Attempt at least 6 of the following

1. Fractional distillation
2. Vacuum distillation
3. Determination of acid value/number of the polymer/resin samples (3 samples)
4. Determination of water absorption of polymer samples (2 samples)
5. Determination of density of liquid/solid polymer samples (2 samples).
6. Determination of moisture content in given polymer samples.
7. Determination of formaldehyde content in the given sample solution by sodium sulphite method.
8. Identification of polymer sample based on solubility (3 samples).
9. Application of different softwares in polymer chemistry-
 - a) Drawing structures of different polymers (representative structures of polysaccharides) in chemistry softwares.
10. Survey of polymer production through Industrial visit – A report.

References:

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3. Encyclopedia of Physical Science and Technology- Polymers, Academic Press
4. F. W. Billmayer, Text book of Polymer Science, 3rd edition, John Wiley & Sons
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9. Premamoy Ghosh, Polymer Science & Technology, 3rd edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi.
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11. Organic Polymer Chemistry- K J Saunders, Chapman and Hall, London.
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15. G. S. Misra, Introductory Polymer Chemistry New age International Publishers & Distributors, New Delhi
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 27. Mohamed A. Fahim, Taher A. Alsahhaf, and Amal Elkilani; Fundamentals of Petroleum Refining, Elsevier.
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 29. The Chemistry and Technology of Petroleum by Speight, CRC Press
 30. Latex technology, D. Kumar, R. Chandra, Dhanpat Rai Publishing
 31. The chemistry of petroleum and its substitutes, A practical handbook by C. K. Tinkler, F. Challenger.
 32. The Stereochemistry of Macromolecules Volume 1, Edited by A. D. Ketley, Marcel Dekker Inc., New York
 33. Distillation principles and processes by Sydney Young
 34. March's Advanced Organic Chemistry, Michael B. Smith, Jerry March, Wiley-Interscience.
 35. Organic Chemistry by T. W. Graham Solomons and Craig B. Fryhle, Wiley
 36. A guidebook to Mechanism in Organic Chemistry by Peter Sykes
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