



CIRCULAR NO.SU/B.Sc./CBC&GS /69/2023

It is hereby inform to all concerned that, the syllabi prepared by the Board of Studies, Ad-hoc Boards and recommended by the Dean, Faculty of Science & Technology, the Hon'ble Vice-Chancellor has accepted the **following syllabi of Bachelor of Science with Practical Pattern of Question Paper under the scheme of Choice Based Credit & Grading System** in his emergency powers under section 12(7) of the Maharashtra Public Universities Act, 2016 on behalf of the Academic Council as appended herewith.

Sr.No.	Courses	Semester
1.	B.Sc. Biotechnology (Optional)	IIIrd & IVth semester
2.	B.Sc. Microbiology (Optional)	IIIrd & IVth semester
3.	B.Sc. Information Technology (Optional)	IIIrd & IVth semester
4.	Bachelor of Computer Application (Optional)	IIIrd & IVth semester
5.	B.Sc.Polymer Chemistry (Optional)	IIIrd & IVth semester
6.	B.Sc.Computer Science (Degree)	IIIrd & IVth semester
7.	Honors Degree of Computer Science	IIIrd & IVth semester
8.	Honors Degree of Biotechnology	IIIrd & IVth semester

This is effective from the Academic Year 2023-24 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,
Aurangabad-431 004.

REF.NO.SU/2023/ 1241-49

Date:- 12.06.2023.

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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.BAMU,A'bad.**
- 2] The Section Officer,[B.Sc.Unit] Examination Branch,Dr.BAMU,A'bad.
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- 5] The In-charge,[E-Suvidha Kendra], Rajarshi Shahu Maharaj Pariksha Bhavan, Dr.BAMU,A'bad.
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**Dr. BABASAHEB AMBEDKAR MARATHWADA
UNIVERSITY, AURANGABAD**



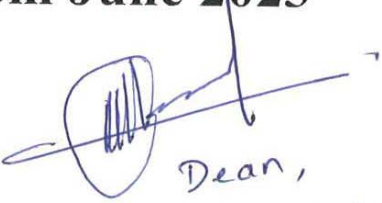
SYLLABUS

**B.Sc. Polymer Chemistry
(Semester III & IV)**

Choice Based Credit and Grading System

Effective From June 2023


Prof. Pathan Mohd Arif Ali Khan
Chairman
Board of Studies in Chemistry,
Dr. Babasaheb Ambedkar Marathwada
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Dean,
Faculty of Sci. & Tech.

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad

Choice Based Credit System (CBCS) Curriculum

For Faculty of Science and Technology

Course Structure and Scheme of Examination

BSc. Three year Undergraduate Degree Program

Subject : Polymer Chemistry

Semester I								
	Course Code	Course Title	Teaching hr/ Week	Credits	Scheme of Examination			
					Max Marks	CIA	UA	Min Marks
Optional (DSC-1C) Core Courses	PCH 111	Core Course (Theory Paper I) Basic concepts in Polymer chemistry-I	2	2	50	10	40	20
	PCH 112	Core Course (Theory Paper II) Basic concepts in Polymer chemistry-II	2	2	50	10	40	20
	PCH 121	Lab Course 1 (PCH-111 -PCH-112)	3	1.5	50	10	40	20
Total Credits for Semester I: 5.5 (Theory:04 ; Laboratory: 1.5)								

Semester II								
	Course Code	Course Title	Teaching hr/ Week	Credits	Scheme of Examination			
					Max Marks	CIA	UA	Min Marks
Optional (DSC-1D) Core Courses	PCH 211	Core Course (Theory Paper III) Natural polymers	2	2	50	10	40	20
	PCH 212	Core Course (Theory Paper IV) Raw material of polymers and polymerization reaction	2	2	50	10	40	20
	PCH 221	Lab Course 2 (PCH-211 PCH-212)	3	1.5	50	10	40	20
Total Credits for Semester IV: 5.5 (Theory:04; Laboratory: 1.5)								

Practicals exam of both I and II semester will be conducted at the end of second term


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Semester III								
	Course Code	Course Title	Teaching hr/ Week	Credits	Scheme of Examination			
					Max Marks	CIA	UA	Min Marks
Optional (DSC-1C) Core Courses	PCH 311	Core Course (Theory Paper V) Kinetics of polymerization	2	2	50	10	40	20
	PCH 312	Core Course (Theory Paper VI) Chemistry of polymer material- I	2	2	50	10	40	20
	PCH 321	Lab Course 3 (ACH-311)	3	1.5	50	10	40	20
	PCH 322	Lab Course 4 (PCH-312)	3	1.5	50	10	40	20
SEC	CHE 313 Select any one from SEC-1A & SEC-1B	CHE 313 SEC-1A Laboratory safety and Laboratory Practices	2	2	50	10	40	20
		CHE 313 SEC-1B Water Analysis	2	2	50	10	40	20
Total Credits for Semester III: 07+02 (Theory:04+02; Laboratory: 03)								

Semester IV								
	Course Code	Course Title	Teaching hr/ Week	Credits	Scheme of Examination			
					Max Marks	CIA	UA	Min Marks
Optional (DSC-1D) Core Courses	PCH 411	Core Course (Theory Paper VII) Thermodynamics of polymer and polymer solution	2	2	50	10	40	20
	PCH 412	Core Course (Theory Paper VIII) Chemistry of polymer material- I	2	2	50	10	40	20
	PCH 421	Lab Course 5 (PCH-411)	3	1.5	50	10	40	20
	PCH 422	Lab Course 6 (PCH-412)	3	1.5	50	10	40	20
SEC	CHE 413 Select any one from SEC-2A & SEC-2B	CHE413 SEC-2A Pharmaceuticals Chemistry	2	2	50	10	40	20
		CHE413 SEC-2B Industrial Fermentation & Alcohol Technology	2	2	50	10	40	20
Total Credits for Semester IV: 07+02 (Theory:04+02; Laboratory: 03)								

Practicals exam of both III and IV semester will be conducted at the end of second term


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Semester V								
	Course Code	Course Title	Teaching hr/ Week	Credits	Scheme of Examination			
					Max Marks	CIA	UA	Min Marks
Optional (DSC-1C) Core Courses	PCH 511	Core Course (Theory Paper IX)	2	2	50	10	40	20
	PCH 512	Core Course (Theory Paper X)	2	2	50	10	40	20
	PCH 521	Lab Course 7 (PCH-511)	3	1.5	50	10	40	20
	PCH 522	Lab Course 8 (PCH-512)	3	1.5	50	10	40	20
SEC	CHE 513 Select any one from SEC-3A & SEC-3B	CHE 513 SEC-3A	2	2	50	10	40	20
		CHE 513 SEC-3B	2	2	50	10	40	20
Total Credits for Semester III: 07+02 (Theory:04+02; Laboratory: 03)								

Semester VI								
	Course Code	Course Title	Teaching hr/ Week	Credits	Scheme of Examination			
					Max Marks	CIA	UA	Min Marks
Optional (DSC-1D) Core Courses	PCH 611	Core Course (Theory Paper XI)	2	2	50	10	40	20
	PCH 612	Core Course (Theory Paper XII)	2	2	50	10	40	20
	PCH 621	Lab Course 9 (PCH-411)	3	1.5	50	10	40	20
	PCH 622	Lab Course 10 (PCH-412)	3	1.5	50	10	40	20
SEC	CHE 613 Select any one from SEC-4A & SEC-4B	CHE 613 SEC-4A	2	2	50	10	40	20
		CHE 613 SEC-4B	2	2	50	10	40	20
Total Credits for Semester IV: 07+02 (Theory:04+02; Laboratory: 03)								

Practicals exam of both V and VI semester will be conducted at the end of second term


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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.

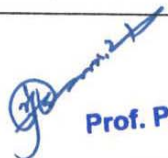
Practical examination: Annual examination.



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(Semester-III)

Paper-VII: (PCH-301) Kinetics of Polymerization		2 Credits (45 Hrs)
Unit No.	Content	Hrs
Unit 1:	Types of Polymerization Processes: Types Chain/Addition polymerization and subtypes, Co-polymerization, Controlled polymerization, living polymerizations. Mechanism of Polymerization Processes: Free Radical addition Polymerization, Ionic Polymerization - Cationic and Anionic, and coordination chain Polymerization. Ring opening polymerization-mechanism of polymerization of cyclic ethers, cyclic amides and cyclosiloxanes. mechanisms of copolymerization, block and graft copolymers. Condensation polymerization: Types and Mechanisms	10
Unit 2:	Kinetics of polymerization reactions: Order and Molecularity, Rate Law, Differential form of rate, Integrated Rate Law, rate constant, degree of polymerization. Cationic and Anionic Polymerization: Overall Rate of polymerization, Number-Average Degree of Polymerization. Co-polymerization: Copolymer composition equation, rate of copolymerization Controlled polymerization methods: Nitroxide mediated polymerization (NMD), Atom Transfer Radical Polymerization (ATRP), Group Transfer Polymerization (GTP), Reversible Addition Fragmentation Termination (RAFT). Condensation polymerization: Chemical Kinetics of step reaction Polymerization. Kinetic expression for polymerization in presence and absence of catalyst.	15
	Thermal Properties of Polymers: Softening Range, Thermal conductivity and Expansion. Glass, Glass transition and melting transition temperature, Crystallization temperature.	12
Unit 3:	Thermodynamics of Glass Transition, First and second Order phase transition, Kauzmann Temperature, Glass Transition Temperature. determination of glass transition temperature: Dilatometry, Calorimetry, Dynamic Mechanical Analysis, factors affecting glass transition temperature. glassy solids. Flammability of polymers.	
Unit 4:	Electrical and Optical Properties and Weatherability of Polymers: Dielectric Constant, Electrical Resistance, Dissipation Factor and Power Loss, Electrical Conductivity and Dielectric Strength. Index of Refraction, Optical Clarity, Absorption and Reflectance of polymers. Weatherability of polymers.	08


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Paper-VIII (PCH-302) Chemistry of Polymer Material- I		2 Credits (45 Hrs)
Unit 1:	Polyolefins: Raw materials, schematic polymerization reactions of ethene, propene and isobutylene; free radical polymerization of ethylene, polymerization reaction of Propene using Zeigler–Natta catalyst, Polyethylenes: HDPE, UHMWPE, LDPE, LLDPE, and ULPE; properties and uses of various PEs, Polypropylene, and Polyisobutylene.	05
Unit 2:	Synthetic Polyamides and polyimides: Introduction, history, nomenclature, aliphatic and aromatic nylons, raw materials of nylon 6, nylon 66, and nylon 6,T; their preparation, Schematic Reactions for the Formation of Polyamides: Amidation of amino acids, Amidation of diamine and diacid, Amidation of acid chlorides, Lactam polymerization (cationic, anionic and hydrolytic); synthesis of nylon 6, nylon 66, and nylon 6,T; Aramids: Poly(p-phenylene terephthalamide), Poly(m-phenylene isophthalamide); properties and applications of polyamides (nylons and aramids); synthesis of polyimides from i) 4-aminophthalic anhydride, ii) diimides with dihalides, iii) diisocyanates with dianhydrides, iv) dianhydrides and oxy-dianiline, v) dianhydrides and methylene dianiline.	10
Unit 3:	Poly(vinyl chloride) and other halogen-bearing polymers: Introduction, History and development of PVC, PVC sector of the plastic industry; Raw materials - Preparation of vinyl chloride monomer, PVC homopolymers: Chemical structure, polymerization methods, chain branching, and end groups, UPVC, CPVC, solution and suspension polymerization; Properties and applications of PVC; Other halogen-bearing polymers: Poly (vinylidene chloride), PTFE, Polychlorotrifluoroethylene, Poly(vinylidene fluoride), Poly(vinyl fluoride) :- Synthesis of monomers, repeating units, properties and applications.	12
Unit 4:	Polyurethanes and Polyureas : Raw materials, polyfunctional isocyanates and their preparation, polymerization reactions, PU ionomers, PU foams, elastomers and fibers, properties and applications.	12
Unit 5:	Polycarbonates: Raw material and their preparation, polymerization reactions, preparation by direct phosgenation, Transesterification method, and direct preparation from α,ω -dibromo compounds using crown ethers; properties and application.	06


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Note: Attempt at least 6 of the following

1. Hints for Maintaining safety in the Laboratory (Compulsory)
2. Determination of Crystallite Melting Point using melting-point microscope or DSC.
3. Determination of glass transition temperature and crystallization temperature using DSC.
4. Preparation of PMMA by Controlled Radical Polymerization (ARTP) of Methyl Methacrylate in miniemulsion.
5. Controlled Radical Polymerization (RAFT) of Trimethylsilylpropargyl Methacrylate.
6. Preparation of Polyester from ϵ -Caprolactone using Novozym 435 catalyst.
7. Preparation of Polypropylene using Ziegler-Natta Catalysts in Organic Suspension.
8. Anionic ring-opening polymerization of ϵ -Caprolactam in Bulk (Flash polymerization).
9. Ring opening polymerization of THF using Antimony pentachloride in Bulk.
10. Ring opening polymerization of Trioxane using BF_3 -ether as an initiator.
11. Drawing Mechanism of polymerization reactions using chemical structure drawing softwares:
Ring opening / ionic / coordination / condensation polymerization.


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Paper-X: (PCHL-304) Lab Course-IV

1.5 Credits (45 Hrs)

Note: Attempt at least 6 of the following

1. Hints for Maintaining safety in the Laboratory (Compulsory)
2. Cationic Polymerization of Isobutylene.
3. Preparation of Nylon-6,6 by polycondensation of Nylon salt.
4. Preparation of Nylon-6,10 by polycondensation in solution.
5. Preparation of Nylon-6,6 or Nylon-6,10 by interfacial polymerization.
6. Preparation of Nylon-6 from ϵ -Aminocaproic acid in the Melt.
7. Preparation of polyimide from Dianhydride and Dianiline.
8. Preparation of Polycarbonate by Transesterification in melt.
9. Preparation of Polyurethane prepolymer.
10. Determination of Amine value of Resins: Reactive Polyamides.
11. Determination of Amine value of Resins: Non-reactive Polyamides.
12. Determination of Isocyanate content of Resins.
13. Determination of Chlorine Content of PVC.
14. Drawing Schematic polymerization reactions using chemical structure drawing softwares:
Nylon-6 / Nylon-6,6 / Nylon-6,10 / Polyimide / Polycarbonate / PVC / PU / halogen bearing polymers.


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Semester- IV

Paper-XI: (PCH-401) Thermodynamics of Polymer Solutions		2 Credits (45 Hrs)
Unit No.	Content	Hrs
Unit 1:	Basic concepts of Thermodynamics: Recapitulation of molecular forces and chemical bonding in polymers. Thermodynamic terms, Enthalpy, Internal energy, Entropy, Gibb's free energy, Sign convention, spontaneous and non-spontaneous processes and Spontaneity of the Dissolution Process of low M.W. compounds.	06
Unit 2:	Polymer Solutions: Criteria of polymer solubility, The process of polymer dissolution, conformations of dissolved polymer chain, thermodynamics of polymer dissolution, theories of polymer solution, nature of polymer molecules in solution, size and shape of polymer molecules in solution, solubility of crystalline and amorphous polymer, effect of molecular weight on solubility, viscosity of dilute and concentrated polymer solution. phase separation in polymer. deviation of polymer solution from ideal solution, true solution. Cohesive energy density, Headle brand theory – Flory Huggins theory and its modifications.	17
Unit 3:	Experimental methods: Monomer purification, isolation and purification of polymers by polymer fractionation, fractionation technique, methods of fractionation, gel permeation chromatography, gradient elution technique, partial dissolution technique.	08
Unit 4:	Morphology and Crystallinity of polymers: Introduction, Configurations of polymer chains, crystal structures of polymers, Morphology of polymer single crystals, structure of polymers crystallized from melt, during flow and from solution, crystallization processes.	14

Paper-XII: (PCH-402) Chemistry of Polymer Materials - II		2 Credits (45 Hrs)
Unit 1:	Polyacrylates, polymethacrylates and other Acrylic Polymers: Introduction, monomer preparation, and repeating units of polymers based on acrylic acid, methacrylic acid, esters of acrylic acid and methacrylic acid, acrylamide, acrylonitrile and cyanoacrylate. free radical polymerization reaction of methyl methacrylate, Polymerization of methyl methacrylate by bulk, solution and suspension polymerization, properties and applications of acrylic polymers.	10
Unit 2:	Epoxy resins: Raw material and their preparation, Preparation of epoxy resin, cross linking reactions, epoxy value, liquid and solid epoxies, their properties and applications.	08


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Unit 3:	Polyesters: Introduction, Preparation of polyesters from Hydroxycarboxylic acids, from lactones, cationic, anionic and coordination mechanisms, PET: Raw material and their preparation, polymerization reaction, preparation by melt condensation; properties and applications.	08
Unit 4:	Phenolic and amino Polymers: Phenol-Formaldehyde Resins, Resols, Novolaks- Introduction, raw materials and their preparation, preparation of novolaks, resols, resin manufacture and moulding powder; Amino polymers:- Urea-Formaldehyde Resins, Melamine-Formaldehyde Resins, raw materials and their preparation, resin manufacture, properties and applications.	12
Unit 5:	Polysiloxanes: Introduction, Starting materials, their preparation, silicones synthesis, branching and crosslinking, properties and applications.	07


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Paper-XIII: (PCHL-403) Lab Course-V**1.5 Credits (45 Hrs)**

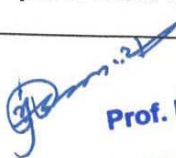
Note: Attempt at least 6 of the following

1. Hints for Maintaining safety in the Laboratory (Compulsory)
2. Determination of Moisture Content of Resins or Polymer solutions: Oven drying / Karl Fischer / Determination of Free water (Azeotropic method)
3. Determination of K value of PVC Resin.
4. Purification of monomers: THF / Trioxane / Methyl methacrylate.
5. Gel Permeation Chromatography: Fractionation of Polyacrylamide in Water.
6. Determination of Density of the given solid Polymer sample heavier than water.
7. Determination of Density of the given solid Polymer sample lighter than water.
8. Determination of Viscosity of polymers using a Brookfield Viscometer.
9. Determination of Swelling of Network polymers.
10. Determination of Tacticity of Polypropylene.
11. Determination of water absorption of polymers.
12. Determination of Crystallinity of Polymer sample: FT-IR / XRD.
13. Determination of percent crystallinity using Excel / Origin Software.
14. Determination of Density of the Powder / Granules / liquids using specific gravity bottle.
15. Survey of polymer production through Industrial visit – A report.

Paper-XIV: (PCHL-404) Lab Course-VI**1.5 Credits (45 Hrs)**

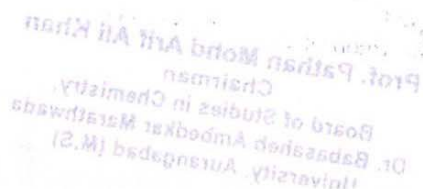
Note: Attempt at least 6 of the following

1. Solution polymerization (Precipitation polymerization) of Acrylonitrile.
2. Preparation of polyacrylonitrile (Precipitation polymerization) with a Redox system in Aqueous Solution.
3. Preparation of polymethacrylic Acid with Potassium Peroxodisulfate in Aqueous Solution.
4. Preparation of PMMA by Polymerization of Methyl Methacrylate using AIBN in Bulk.
5. Polymerization of Methyl Methacrylate with Butyllithium in Solution.
6. Preparation of Polyacrylamide with a Redox System in Aqueous Solution.
7. Preparation of Phenol-Formaldehyde resin: Novolak.
8. Preparation of Phenol-Formaldehyde resin: Resol.
9. Preparation of Urea-Formaldehyde resin.
10. Preparation of Polyester Resin by Melt condensation method.


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11. Preparation of Polyester Resin by Solution condensation method.
12. Preparation of Epoxy resin.
13. Determination of Saponification value of Polyesters.
14. Determination of Epoxy equivalent and Epoxy value of Resins.
15. Determination of loss of Glycol in a Polyesterification reaction.
16. Preparation of Polysiloxane.
17. Drawing Schematic polymerization reactions using chemical structure drawing softwares:
Acrylic polymers / epoxies / phenolic and amino polymers / Polyesters / polysiloxanes.


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3. Encyclopedia of Physical Science and Technology- Polymers, Academic Press
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