| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **CO 4** | 1 | 1 | 1 | 1 | - | 1 | - | - | - | - | 2 | - | - |
| 1 | 1 | **CO 5** | 1 | 12 | 13 | - 2 | - 2 | 1 | - - | 3 - | - | - | 2 | - | - |



**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | ✓ | ✓ | ✓ | ✓ |



**University of Kerala**

| | |
|---|---|
| Discipline | CHEMISTRY |
| Course Code | **UK1MDCCHE101** |
| Course Title | **POLYMERS AND BIOPOLYMERS** |
| Type of Course | **MDC** |

| | | | | | |
|---|---|---|---|---|---|
| Semester | I | | | | |
| Academic Level | 100 - 199 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 3 | 3 hours | - | - | 3 |
| Pre-requisites | 1. Basic knowledge and interest in science | | | | |
| Course Summary | This course provides a comprehensive understanding of the fundamental principles of polymer chemistry and a brief idea of biopolymers. | | | | |

**Detailed Syllabus:**

| Module | Unit | Content<br>POLYMERS AND BIOPOLYMERS | 45 Hrs |
|---|---|---|---|
| **I** | **BASIC PRINCIPLES OF POLYMERS** | | **6** |
| | 1 | General Introduction to Polymers: Macro Molecules, Oligomers, Polymers, Degree of Polymerisation, Functionality. | 2 |
| | 2 | Classification of Polymer: Origin, Structure, Synthesis, Molecular forces. | 1 |
| | 3 | Polymer Synthesis- Synthesis of Copolymers, Block-Polymers, Polyesters, Poly Olefins, Polyamides, Polycarbonates. | 2 |
| | 4 | Chemistry of Polymerization- Addition polymerization and Condensation polymerization. | 1 |
| **II** | **COMMERCIAL POLYMERS** | | **6** |
| | 5 | Commercially important polymers and their applications: Poly ethylene, Polypropylene, Polystyrene, Polyesters, Polyvinyl Chloride (PVC). | 2 |
| | 6 | Polymethylmethacrylate, Bakelite, Natural Rubber, Nylon-6, Nylon-66, Melamine, Terylene. | 3 |
| | 7 | Numbering of Plastics (Plastic identification code) | 1 |
| **III** | **RUBBER CHEMISTRY AND TECHNOLOGY** | | **9** |
| | 8 | Natural and Synthetic Rubber: Historical review, Physical and Chemical Properties of Natural Rubber. | 2 |
| | 9 | Manufacture, Physical Properties and Applications of Synthetic Rubbers such as SBR, Nitrile, Butyl Rubber. | 2 |
| | 10 | EPDM, Neoprene, Vulcanisation of Rubber | 1 |
| | 11 | Rubber Processing- Milling, Mixing, Extrusion, Calendering, Molding and Curing (Explanation only) | 2 |
| | 12 | Rubber Reinforcement Technologies: Brief introduction, Role of Fillers and Reinforcements – Carbon Black. | 2 |
| **IV** | **BIOPOLYMERS** | | **15** |
| | 13 | Introduction of biopolymers, Its classification on the basis of Type, Origin, Monomeric Units. | 2 |
| | 14 | Sources of Biopolymers, Need for Biopolymers. | 2 |

| | | | |
|---|---|---|---|
| | 15 | Introduction to Cellulose, Cotton, Wool, Silk | 2 |
| | 17 | Structure and functions of bio-polymers (basic idea only): Proteins, Nucleic acid, Polysaccharides, starch, shellac and cellulose. | 4 |
| | 18 | Biopolymers from Renewable Resources, Biocompatibility Requirements. | 2 |
| | 19 | Synthetic Biopolymers: Polylactic acid and its co-polymers, Aliphatic Polyesters, Polyethylene Oxides and its Copolymers. | 3 |
| **V** | **OPEN ENDED MODULE:** | | **9** |
| | 20 | Seminar presentations, group discussions, debates, quizzes etc on<br>a. Identification of polymer in a variety of common objects made from different types of polymers<br>b. A specific biopolymer (e.g., cellulose, starch, chitin) and its application in various industries<br>c. Recycling or upcycling of polymer waste<br>d. Extraction of biopolymers from natural sources<br>e. Biodegradation behavior of biopolymers in different environmental conditions<br>(Or any other similar topics suggested by the teacher) | 9 |

**References**


1. F.W. Billimeyer, "*Textbook of Polymer Science*", Wiley, India 2007.
2. V.R. Gowarikar, "*Polymer Science*", New Age International Publishers Ltd 2010.
3. P.J. Flory, "*Principles of Polymer Chemistry*", Asian Books Private Ltd 2006.
4. P. Ghosh, "*Polymer Science and Technology of Plastic and Rubber*", Tata McGraw Hill 2010.
5. M.P. Stevens, "*Polymer Chemistry*", Oxford University Press, Inc, 1990.
6. R. M Johnson, L Y Mwaikambo and N Tucker, "*Biopolymers*", Rapra Technology 2003.
7. S. Kalia and L. Avérous, "*Biopolymers: Biomedical and Environmental Applications*".




## Course Outcomes

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO-1 | Analyze the structure, classification, synthesis methods, and polymerization mechanisms of various polymers, including copolymers and key polymer classes, to understand their macromolecular properties and functionalities. | An | PSO-1,2,3 |

| | | | |
|---|---|---|---|
| CO-2 | Analyze the structure, properties, and diverse industrial applications of key commercial polymers—including polyethylene, polypropylene, polystyrene, polyesters, PVC, polymethylmethacrylate, Bakelite, natural rubber, nylons, melamine, and terylene—while interpreting plastic identification codes for effective material classification and sustainable usage. | An | PSO-1,2,3,4 |
| CO-3 | Critically evaluate the historical development, chemical and physical properties, manufacturing processes, and industrial applications of natural and synthetic rubbers, including vulcanization and reinforcement technologies, demonstrating a comprehensive understanding of rubber processing techniques and material enhancements. | E | PSO-1,2,3 |
| CO-4 | Critically analyze the classification, structure, sources, and functional properties of natural and synthetic biopolymers, and creatively apply this knowledge to innovate sustainable materials with biocompatibility for diverse industrial and biomedical applications. | C | PSO-1,2, 3 |
| CO-5 | Critically analyze, evaluate, and creatively present the identification, industrial applications, sustainable recycling methods, extraction techniques, and environmental biodegradation behaviors of various polymers and biopolymers, demonstrating advanced understanding and innovative problem-solving skills in polymer science. | C | PSO-1,2,3,4,5 |

**R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create**

**Name of the Course: POLYMERS AND BIOPOLYMERS**

**Credits: 3:0:0 (Lecture:Tutorial:Practical)**

| CO No. | CO | PO/ PSO | Cognitive Level | Knowledge Category | Lecture (L)/ Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| 1 | CO-1 | PO-1,6<br>PSO-1,2,3 | An | F, C | L | - |
| 2 | CO-2 | PO-1,6<br>PSO-1,2,3,4 | An | F, C | L | - |

| | | | | | | |
|---|---|---|---|---|---|---|
| 3 | CO-3 | PO-1,6<br>PSO-1,2,3 | E | F, C | L | - |
| 4 | CO-4 | PO-1,6<br>PSO-1,2 | C | F, C, P | L | - |
| 5 | CO-5 | PO-1,2,3,4,5,6,8<br>PSO-1,2,3,4,5 | C | F, C, P | L | - |

**F-Factual, C- Conceptual, P-Procedural, M-Metacognitive**

**Mapping of COs with PSOs and POs:**

| | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | 1 | 1 | - | - | 1 | - | - | - | - | 2 | - | - |
| **CO 2** | 2 | 1 | 2 | - | - | 1 | - | - | - | - | 2 | - | - |
| **CO 3** | 2 | 2 | 2 | - | - | 1 | - | - | - | - | 2 | - | - |
| **CO 4** | 2 | 1 | 1 | - | - | 1 | - | - | - | - | 2 | - | - |
| **CO 5** | 2 | 1 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | - | 2 |

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