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## First SEMESTER 2021-2022

**Course Handout (Part II)**

#### Date: 20/08/2021

In addition to part I (General Handout for all courses appended to the time table) this portion gives further specific details regarding this course.

**Course No. : CHEM F325**

##### Course Title : POLYMER CHEMISTRY

###### Instructor‑in‑charge : Dr. Chanchal Chakraborty

1. **Scope and Objective of the course:** The objective of the present course is to introduce the foundation of the subject by studying types and structures of polymers, molecular weight of polymers, kinetics of polymerization, thermodynamics of polymer solutions, thermal and mechanical properties of solid polymers, polymer’s viscoelasticity and rubber elasticity, commodity, network, engineering and specialty polymers and applications for polymers in separations, biotechnology and electronics.
2. **Text Book (TB):** Fried, Joel R., Polymer Science and Technology, 2nd Edition, Prentice-Hall of India Pvt. Ltd. New Delhi, 2005.
3. **Reference Books (RB):** (a) Bahadur, P. and Sastry, N.V., Principles of polymer Science, Narosa Publishing House, New Delhi, 2002. (b)V R Gowarikar, NV Vishwanathan, Jayadev Sreedhar, First Edition 1986, Polymer Science, Reprint 2009. New age International limited (p).

***The syllabus also includes lectures class notes.***

1. **Course Plan:**

| **Lecture No.** | **Learning objectives** | **Topics to be covered** | **Chapter in the Text Book** | **Learning Outcomes** |
| --- | --- | --- | --- | --- |
| 1 | Classification of polymers, structure of polymers, molecular weights and chemical structure | (i) Classification of polymers | TB 1.1,  RB(a) 1.2 | Recognize various types of polymers based on their chemical structures, calculation of molecular weight of the polymers and analysis |
| 2 | (ii) Polymer structure and isomerism | TB 1.2,  RB(a) 1.4 |
| 3-4 | (iii) Molecular weight and chemical structure and thermal transitions | TB 1.3 & 1.4,  RB(a) 3.3.1 |
| 5 | Synthesis and kinetics of different types of polymerization | (i) Step-growth polymerization | TB 2.1,  RB(a) 2.2 | Demonstrate techniques and methodologies adopted in polymers synthesis |
| 6-7 | (ii) Chain-growth polymerization | TB 2.2,  RB(a)2.1 |
| 8-9 | The different techniques of polymerization and the reactions of synthetic polymers | Polymerization techniques, reactions of synthetic polymers and special topic in polymer synthesis | TB 2.3-2.5 | Envisage reactions of synthetic polymers and outline special topics encountered in polymers synthesis |
| 10 | Different model to explain conformations and chain dimensions | Polymer conformation and chain dimension | TB 3.1 | Comprehensive study of polymer conformations and their chain dimensions |
| 11 | How thermodynamics of polymers solutions differs from the thermodynamics of ordinary solutions | (i) Flory-Huggins theory and Flory-Krigbaum and modified Flory-Huggins theory | TB 3.2.1 & 3.2.2,  RB (a) 4.3 | Recognize the need of Flory- Huggins and related modified theories to outline the thermodynamics of polymer solutions. Interpret interaction parameter and also to predict the solubility of polymers in various solvents |
| 12 | (ii) phase equilibria | TB 3.2.4 |
| 13 | (iii) Determination of interaction parameter and prediction of solubilities | TB 3.2.5 & 3.2.6  RB (a) 4.3 |
| 14 | The principles behind both primary and secondary methods for molecular-weight determination | (i) Osmometry | TB 3.3.1,  RB (a) 3.3.3 | Types of experimental methodology from simple laboratory to high end gel permeation techniques, involved to determine the molecular weight of polymers |
| 15 | (ii) Light-Scattering method | TB 3.3.2,  RB (a) 3.3.3 |
| 16 | (iii) Intrinsic-Viscosity measurement | TB 3.3.3  RB (a) 3.3.3 |
| 17 | (iv) Gel-Permeation Chromatography | TB 3.3.4 |
| 18 | Thermal and mechanical properties of different solid states of polymers | (i) Amorphous state | TB 4.1.1-4.1.3 | Acquire knowledge on different phases of solid polymeric materials and their thermal transitions. Glass transition temperature (Tg) and melting temperature (Tm), get an idea about the variation of Tg and Tm with polymer structure and functionalities. Importance of Tg regarding mechanical properties of polymers. |
| 19 | (ii) Crystalline state | TB 4.2.1 - 4.2.4 |
| 20 | (iii) Thermal transitions and properties | TB 4.3.1 & 4.3.2 |
| 21 | (iv) Structure property relationships, effect of molecular weight, composition and pressure on Tg | TB 4.3.3 & 4.3.4 |
| 22 | (v) Mechanical properties | TB 4.4 |
| 23 | Introduction to viscoelasticity and rubber elasticity | (i) Introduction to viscoelasticity | TB 5.1.1,  RB (a) 4.4 | Experience the basic of viscoelasticity and rubber elasticity and will be able to describe a polymer's elastic behavior in light of its structure |
| 24 | (ii) Introduction to rubber elasticity | TB 5.2 |
| 25 | Effects of environmental agents on polymers | Polymer degradation, stability and management | TB 6.1 & 6.2 | Knowledge of basic principles and mechanisms of degradation of synthetic polymers and environmental impacts of synthetic polymer.  Absorb the technical application capabilities of the most used commodity plastics |
| 26 | Effect of additives, blends and composites on the properties of polymers | (i) Additives and blends | TB 7.1.1  - 7.1.3,7.2.1 | The role of additives in polymer blend. Methods of polymer composites preparation and their applications |
| 27-28 | (iii) Polymer composites | TB 7.3.1 |
| 29 | Polymers in biological systems and nature | Biopolymers and other naturally occurring polymers | TB 8.1 | Acquire skill on the chemical structure and applications of naturally occurring biopolymers like proteins, polynucleotide and Polysaccharides and natural fibers. |
| 30 | To know different types of thermoplastics and fibers and their properties | (i) Fibers | TB 8.2.1 – 8.2.3  RB 5.3 | Discover the natural and synthetic fibers, cellulosics and non-cellulosics etc. Idea about commodity thermoplastics like polyolefins, vinyl polymers and thermoplastic polyesters. |
| 31 | (ii) Thermoplastics | TB 9.1  RB (a) 5.2 |
| 32 | To know different types of network polymers and their properties | (i) Elastomers | TB 9.2, RB (a) 5.4 | Interpretation of the basic of elastomers and thermosets. Idea about diene and non-diene elastomers and epoxy and phenol-formaldehyde resin type thermosets. |
| (ii) Thermosets | TB 9.3 |
| 33 | Introduction to some outstanding polymers and their properties and comparison with commodity thermoplastics | (i) Engineering thermoplastics | TB 10.1 | Apprehension about the engineering plastics like polyamides. ABS, polycarbonates, PEO, polysulfones etc. and polyimides and related specialty polymers and high-performance fibers. |
| 34 | (ii) Specialty polymers | TB 10.2, RB (a)  Ch. 8 |
| 35-36 | Applications for polymers in separations, biotechnology and electronics | (i) Membrane separations & preparation | TB 12.1.2 | Recognize the membrane science and technology, barrier polymers etc. Awareness about biomedical engineering and polymer based controlled drug delivery system. |
| Membrane separation, Biomedical applications, applications in electronics and photonic polymers | TB 12.2-12.4 |
| 37-40 | Online video tutorial of lab components and discussion for the experiences in linear (polyaniline) and cross-linked polymer synthesis, molecular weight measurement, applications etc. | |  | Students will get some experiences on polymer synthesis, characterizations and their properties. |

1. **Evaluation Scheme:**

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| --- | --- | --- | --- | --- |
| **Component** | Duration | **Weightage (%)** | **Date & Time** | **Nature of Component** |
| Mid Semester Examination | 90 Minutes | 30 | 22/10/2021 9.00 - 10.30AM | **OPEN BOOK** |
| Online Lab component and quizzes/assignment on lab component | - | 10 | TBA | **OPEN BOOK** |
| Surprise tests/Quizzes | - | 20 | Continuous | **OPEN BOOK** |
| Comprehensive Examination | 2 hours | 40 | 22/12 FN | **Closed Book** |

**•** Regular attendance in the class will be considered as a plus during the final evaluation.

1. **Consultation Hour:** To be announced in the class
2. **Notice:** Notices concerning this course will be displayed only on the CMS.
3. **Make-up-policy**: Make up would be considered only for very genuine reasons (*such as institute deputation outside for sports/cultural fest, hospitalization (with appropriate documentary proof)* and in case of any other extreme emergency situations.
4. **Academic Honesty and Integrity Policy**: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

Dr. Chanchal Chakraborty

**Instructor‑in‑charge, CHEM F325**