Birla Institute of Technology & Science, Pilani
Hyderabad Campus

First SEMESTER 2023-2024
Course Handout (Part II)

Date: 11/08/2023

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. Subit Kumar Saha**
Instructors : **Dr. Subit Kumar Saha, 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 the types and structures of polymers, the molecular weight of polymers, the kinetics of polymerization, the 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, N V Vishwanathan, Jayadev Sreedhar, First Edition 1986, Polymer Science, Reprint 2009. New age International limited (p).

The syllabus also includes lectures class notes.

4. **Course Plan:**

Lecture No.	Learning objectives	Topic	Chap./ Sec. No.	Learning Outcomes
1	Classification of polymers, polymer structure and isomerism, molecular weights and chemical structure, and thermal transitions.	(i) Classification of polymers	TB 1.1, RB(a) 1.2	Recognize various types of polymers based on their chemical structures, isomerism of polymers, calculation of molecular weights of the polymers and analysis, and the
2		(ii) Polymer structure and isomerism	TB 1.2, RB(a) 1.4	

Lecture No.	Learning objectives	Topic	Chap./ Sec. No.	Learning Outcomes
3-4		(iii) Molecular weight and chemical structure and thermal transitions	TB 1.3 & 1.4, RB(a) 3.3.1	relation between the structure of polymers and thermal properties.
5	Synthesis and kinetics of different types of polymerizations	(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	A 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 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 in determining 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 (T_g) and melting temperature (T_m), get an idea about the variation of Tg and Tm with polymer structure and functionalities. Importance of T_g 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 T_g	TB 4.3.3 & 4.3.4	
22		(v) Mechanical properties	TB 4.4	

Lecture No.	Learning objectives	Topic	Chap./ Sec. No.	Learning Outcomes
23	Introduction to viscoelasticity and rubber elasticity	(i) Introduction to viscoelasticity	TB 5.1.1, RB (a) 4.4	Experience the basics of viscoelasticity and rubber elasticity and knowledge of a polymer's elastic behavior in the 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 synthetic polymers' degradation and synthetic polymer's environmental impacts. 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 the polymer blend. Methods of polymer composites preparation and their applications
27-28		(iii) Polymer composites	TB 7.3	
29	Polymers in biological systems and nature	Biopolymers and other naturally occurring polymers	TB 8.1	Acquire knowledge of the chemical structure and applications of naturally occurring biopolymers like proteins, polynucleotides, 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. An 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. An 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 membrane science and technology, barrier polymers etc. Awareness about biomedical engineering, conductive polymers, and polymer-based controlled drug delivery systems.
		Membrane separation, Biomedical applications, applications in electronics and photonic polymers	TB 12.2-12.4	

Lecture No.	Learning objectives	Topic	Chap./ Sec. No.	Learning Outcomes
37-40	Lab components and discussion for the experiences in linear (polyaniline) and cross-linked polymer synthesis, molecular weight measurement, applications etc.			Students will get hands-on experience in polymer synthesis, characterizations, and properties.

5. Evaluation Scheme:[1]

Component	Duration	Weightage (%)	Date & Time	Nature
Mid Semester Examination	90 Minutes	30	09/10 - 11.30 - 1.00PM	**Closed BOOK**
Lab component and quizzes/assignments on lab component[2]	-	10	**TBA**	**OPEN BOOK**
Quizzes/Assignments[3]	-	20	**Continuous**	**OPEN BOOK**
Comprehensive Examination	3 hours	40	06/12 AN	**Closed Book**

- [1]Regular attendance in the class will be considered as a plus during the final evaluation.

[2]Marks will be awarded for attending and performing lab components and writing quizzes/assignments.

[3]Quizzes/Assignments will be conducted in some of the lecture classes. Problem sets will be assigned, and quizzes will be conducted periodically. Two quizzes and two assignments, each of equal weightage, will be conducted.

6. Chamber Consultation Hour: To be announced in the class

7. Notice: Notices concerning this course will be displayed only on the CMS.

8. 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.

9. Makeup-policy: Makeup would be considered only for very genuine reasons (*such as institute deputation outside for sports/cultural fest, hospitalization (with appropriate documentary proof)*.

Dr. Subit Kumar Saha

Instructor-in-charge, CHEM F325