



**Birla Institute of Technology & Science, Pilani**  
Hyderabad Campus

**FIRST SEMESTER 2020-2021**

**Course Handout Part II**

Date: 17/08/2020

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  
**Instructor** : Prof. Jayanty Subbalakshmi

- 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, 2<sup>nd</sup> 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.*

**4. Course Plan:**

No. of Lectures	Learning objectives	Topic	Chap./ Sec. No.	Learning Outcomes
1	Classification of polymers, structure of polymers, 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, calculation of molecular weight of the polymers and analysis of thermal transitions
2		(ii) Polymer structure and isomerism	TB 1.2, RB(a) 1.4	
2		(iii) Molecular weight and chemical structure and thermal transitions	TB 1.3 & 1.4, RB(a) 3.3.1	
1	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
2		(ii) Chain-growth polymerization	TB 2.2, RB(a)2.1	
1	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
1	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
1	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
1		(ii) phase equilibria	TB 3.2.4	
1		(iii) Determination of interaction parameter and prediction of solubilities	TB 3.2.5 & 3.2.6 RB (a) 4.3	
1	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
1		(ii) Light-Scattering method	TB 3.3.2, RB (a) 3.3.3	
1		(iii) Intrinsic-Viscosity measurement	TB 3.3.3 RB (a) 3.3.3	
1		(iv) Gel-Permeation Chromatography	TB 3.3.4	
1	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
1		(ii) Crystalline state	TB 4.2.1 - 4.2.4	

No. of Lectures	Learning objectives	Topic	Chap./ Sec. No.	Learning Outcomes
1		(iii) Thermal transitions and properties	TB 4.3.1 & 4.3.2	transitions. Glass transition temperature (T <sub>g</sub> ) and melting temperature (T <sub>m</sub> ), get an idea about the variation of T <sub>g</sub> and T <sub>m</sub> with polymer structure and functionalities. Importance of T <sub>g</sub> regarding mechanical properties of polymers.
1		(iv) Structure property relationships, effect of molecular weight, composition and pressure on T <sub>g</sub>	TB 4.3.3 & 4.3.4	
1		(v) Mechanical properties	TB 4.4	
1	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
1		(ii) Introduction to rubber elasticity	TB 5.2	
1	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
1	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
1		(iii) Polymer composites	TB 7.3.1	
1	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.
1	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, cellulose and non-cellulose etc. Idea about commodity thermoplastics like polyolefins, vinyl polymers and thermoplastic polyesters.
1		(ii) Thermoplastics	TB 9.1 RB (a) 5.2	
1	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.
1		(ii) Thermosets	TB 9.3	
1	Introduction to some outstanding polymers and their properties and	(i) Engineering thermoplastics	TB 10.1	Apprehension about the engineering plastics like polyamides. ABS, polycarbonates, PEO,

No. of Lectures	Learning objectives	Topic	Chap./ Sec. No.	Learning Outcomes
1	comparison with commodity thermoplastics	(ii) Specialty polymers	TB 10.2, RB (a) Ch. 8	polysulfones etc. and polyimides and related specialty polymers and high performance fibers.
1	Applications for polymers in separations, biotechnology and electronics	(i) Membrane separations & preparation	TB 12.1.2	Recognise the membrane science and technology, barrier polymers etc. Awareness about biomedical engineering and polymer based controlled drug delivery system.
1		Membrane separation, Biomedical applications, applications in electronics and photonic polymers	TB 12.2-12.4	
6	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.

#### 5. Evaluation Scheme:

Component	Duration(min)	Weightage (%)	Date & Time	Nature
Test I	30	15	September 10 –September 20 (During scheduled class hour)	<b>OPEN BOOK</b>
Test II	30	15	October 09 –October 20 (During scheduled class hour)	<b>OPEN BOOK</b>
Test III	30	15	November 10 – November 20 (During scheduled class hour)	<b>OPEN BOOK</b>
Online Lab component and quizzes/assignment on lab component	-	10		<b>OPEN BOOK</b>
Surprise tests/Quizzes	-	10	Continuous	<b>OPEN BOOK</b>
Comprehensive Examination	120	35	TBA	<b>OPEN BOOK</b>

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

✓ **The minimum cut off marks is 35% to get a valid grade in this course**

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

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

8. **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.
9. **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**

