Birla Institute of Technology & Science, Pilani
Hyderabad Campus

INSTRUCTION DIVISION
First SEMESTER 2019-2020
Course Handout (Part II)

Date: 20/07/2019

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 : **Jayanty Subbalakshmi**
Instructors: Jayanty Subbalakshmi and 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 and tutorial 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	

No. of Lectures	Learning objectives	Topic	Chap./ Sec. No.	Learning Outcomes
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 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.
1		(ii) Crystalline state	TB 4.2.1 - 4.2.4	
1		(iii) Thermal transitions and properties	TB 4.3.1 & 4.3.2	
1		(iv) Structure property relationships, effect of molecular weight, composition and pressure on Tg	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.

No. of Lectures	Learning objectives	Topic	Chap./ Sec. No.	Learning Outcomes
				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, cellulosics and non-cellulosics 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 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.
1		(ii) Specialty polymers	TB 10.2, RB (a) Ch. 8	
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	

No. of Lectures	Learning objectives	Topic	Chap./ Sec. No.	Learning Outcomes
6	Hands-on synthesis, viscosity measurements, polymer synthesis and characterization of some polymers etc.			Students will get hands-on experiences on polymer synthesis, characterizations and their properties.

5. Evaluation Scheme:

Component	Duration	Weightage (%)	Date & Time	Nature
Midsem Test	90 Minutes	35	-	**Closed book**
Labcomponent	-	10	-	**OPEN BOOK** (Conduct,Performance in Practical and Record/Submission on time etc.)
Surprise tests/Quizes		10	-	**Continuous**
Comprehensive Examination*	3 hours	45	-	**Closed book**

- Regular attendance in the class will be considered as a plus during the final evaluation.
- The tutorial hour will be used for a quick review of the highlights of the material covered in the lectures, clarification of doubts and problem solving.

- * The comprehensive examination will be of completely closed book type and consists of two parts. Part A will be of objective type and part B will be of descriptive.
  - ✓ **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 Chemistry Group Notice Board.
8. **Academic Integrity Policy**: It is expected that in compliance with institute rules and regulations, academic integrity should be adhered to/ in all the evaluation components. Malpractice in any form will have serious implications.
9. **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.

Prof. Jayanty Subbalakshmi

Instructor-in-charge, CHEM F325