

## **MSE 4140: Polymer Physics (required)**

### **Catalog Description:** (3-0-3)

Prerequisites: MSE 3001 or MSE 3000 and MSE 4775 or MSE 4777

The course deals Study of Polymer solutions, Physical Chemistry of Polymer Solutions, Scattering as a method to probe polymer solutions and melts, Polymer miscibility, solutions of rod-like macromolecules and formation of ordered phases (liquid crystals), and dynamics of polymers in solution and in melt – This includes studies of diffusion, rheology of polymer solutions and melts, molecular theories to understand the rheological behavior.

**Textbook:** *Polymer Physics* by Micheal Rubenstein and Ralph Colby

**Prepared by:** Mohan Srinivasarao

### **Topics Covered:**

1. General Introduction to polymers, and the bulk properties like viscosity as a function of molecular weight, the shape of the shear modulus for melts and the like.
2. Thermodynamics: emphasizing solutions.
3. Conformations and spatial configurations of polymer chains.
4. Determination of conformations – methods used for such measurements.
5. Dilute polymer solutions: viscosity, light scattering, and colligative properties.
6. Thermodynamics of transitions in polymer solutions: liquid–liquid, liquid crystalline phase transitions.
7. Concentrated solutions, and melts.
8. Statistical theories of viscosity and diffusion in polymers.
9. Introduction to scaling laws.

### **Course Outcomes:**

Outcome 1: The student will possess the fundamental knowledge dealing with polymer science and will be able to successfully pursue advanced studies.

- 1.1 The student will demonstrate a basic understanding of the essential elements of polymer physics – that the polymer chain dimensions affect the bulk properties of these materials.
- 1.2 The student will demonstrate a basic understanding of how the chain dimensions are measured.
- 1.3 The student will demonstrate a basic understanding of how such dimensions impact miscibility of polymers.

Outcome 2: The student will demonstrate the ability to correlate the chain dimensions with bulk properties and the phase behavior of polymeric materials as well as demonstrate an understanding of how the various bulk properties are measured.

- 2.1 The student will demonstrate the ability to calculate parameters that describe the structure, and dynamics of phase separation of polymeric blends and solutions,
- 2.2 The student will demonstrate the ability to calculate molecular parameters from viscoelastic measurements.
- 2.3 The student will be able to design experiments to measure the zero shear viscosity of polymer melts and solutions.

**Correlation between Course Outcomes and Student Outcomes:**

Course Outcomes	Student Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Course Outcome 1.1	x	x			x						
Course Outcome 1.2	x	x			x						
Course Outcome 1.3	x	x			x						
Course Outcome 2.1	x	x			x						x
Course Outcome 2.2, and 2.3	x	x			x						x
<b>Entire Course</b>	<b>3</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>
<b>0 = None or insignificant; 1 = Some; 2 = Moderate; 3 = Strong</b>											

**School of Materials Science and Engineering Student Outcomes:**

- a) an ability to apply knowledge of mathematics, science and engineering
- b) an ability to design and conduct experiments, as well as to analyze and interpret data
- c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- d) an ability to function on multidisciplinary teams
- e) an ability to identify, formulate, and solve engineering problems
- f) an understanding of professional and ethical responsibility
- g) an ability to communicate effectively
- h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- i) a recognition of the need for, and an ability to engage in life-long learning
- j) a knowledge of contemporary issues
- k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice