MSE 4140: Polymer Physics

Credit hours and contact hours: 3-0-0-3

Instructor: Satish Kumar

Textbook: Michael Rubenstein and Ralph Colby. *Polymer Physics,* Oxford University Press, 3rd Edition, 2003.

Specific course information

Catalog description: Physical chemistry of polymer solutions, polymer miscibility, adsorptions, sorptions, plasticization, molecular weights, molecular weight distributions.

Prerequisites: MSE 3001 – Chemical Thermodynamics of Materials and MSE 4775 - Polymer Science & Engineering I

Course: Selected Elective

Specific goals for the course

Outcomes of instruction:

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

Student Outcomes:

(1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

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.

Correlation between Course Outcomes and Student Outcomes:

Course Outcomes	**Student Outcomes**						
	1	**2**	**3**	**4**	**5**	**6**	**7**
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.	X						
1.2 The student will demonstrate a basic understanding of how the chain dimensions are measured.	X						
1.3 The student will demonstrate a basic understanding of how such dimensions impact miscibility of polymers.	X						
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.	X						
2.2 The student will demonstrate the ability to calculate molecular parameters from viscoelastic measurements.	X						
2.3 The student will be able to design experiments to measure the zero-shear viscosity of polymer melts and solutions.	X						

School of Material Science and Engineering Student Outcomes:

(1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
(2) An ability to apply engineering design to produce solutions that meet specified needs with consideration for public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
(3) An ability to communicate effectively with a range of audiences.
(4) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
(5) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
(6) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
(7) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.