MAT 404 / 514 Polymer Physics
Fall 2023

Intended Audience: Seniors/graduate students who are enthusiastic about understanding the physics of polymers. Only a basic working knowledge of calculus, probability, chemistry and physics is assumed.

Aim: To develop the fundamental concepts required to understand polymers melts, solutions and gels in terms of both structure and dynamics.

Instructor: Ozge Akbulut – office: FENS 2046; phone: 9968; e-mail: ozgeakbulut@sabanciuniv.edu

Assistant:

Hours: Lecture -,-

Textbook: Rubinstein & Colby, Polymer Physics (2003). ISBN: 0-19-852059-X

Evaluation:

Grading is based two term exams (25 % each), final (35 %), and assignments (15 %).

COURSE OUTLINE:

Week 1: What is a polymer? Soft matter vs hard matter. A statistical view on chain molecules.

Week 2: Basic definitions: Structure, phases, and weight of polymers. Molar mass distributions and measurements (viscosity measurements and osmometry)

Week 3–4: Ideal chains: Definition of chain conformation; chain dimensions and their distributions. Free energy of an ideal chain.

Week 5: Real chains: Excluded volume and self-avoiding walks. Deformation of chains. Temperature effects.

Week 6: **Midterm I,** Introduction to polymer thermodynamics

Week 7: Thermodynamics of mixing: Energy – entropy of mixing. Phase diagrams. Dilute solutions.

Week 8: Polymer solutions: Type of solvents. Osmotic pressure.

Week 9: Definition of polymer networks. Random branching and gelation: Percolation. Branching with and without gelation. Mean-field and scaling models of gelation.

Week 10: Networks and gels: Rubber elasticity. Swelling.

Week 11: Viscoelasticity.

Week 12: **Midterm II,** Introduction to dynamics. Definition of relaxation phenomena.

Week 13: Dynamics of unentangled polymers: Rouse and Zimm models.

Week 14: Dynamics of entangled polymers. Reptation in melts and semi-dilute solutions.

Course Organization:

- Problem assignments, partial flip-class
- Two midterms and a final exam.
