Polymer Physics (ChE/Ch 148)

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Grading:	50% term paper + 50% homework (5 total homework sets)

Syllabus

Lecture 1	Introduction; a single ideal chain; mean-square end-to-end distance, radius of gyration. (ZGW)
Lecture 2	Gaussian chain. Freely jointed chain. Worm-like chain. (ZGW)
Lecture 3	Stretching and confinement, structure factor.. (ZGW)
Lecture 4	Excluded volume, solvent quality, theta-temperature. (ZGW)
Lecture 5	Polymer solutions: Flory-Huggins Theory, osmotic pressure. (ZGW)
Lecture 6	Polymer solutions: scaling laws for good solvents, concentration fluctuation and correlation length. (ZGW)
Lecture 7	Polymer solutions: Size of a polymer in semi-dilute solutions, poor solvents and phase separation, fractionation. (ZGW)
Lecture 8	Measurements of polymer sizes in solution: osmotic pressure, light scattering, intrinsic viscosity, size-exclusion chromatography. (ZGW)
Lecture 9	Polymer melts / concentrated solutions: chains in melts are ideal, one long chain among short chains, SANS studies of chain dimensions and of correlation hole. (ZGW)
Lecture 10	Polyelectrolytes: Debye-Huckle theory, Donnan equilibrium. (ZGW)
Lecture 11	Rubber elasticity; gels (JAK)
Lecture 12	Polymer-polymer thermodynamics: phase behavior of polymer blends; stability and metastability. (JAK)
Lecture 13	Dynamics of polymeric liquids: phenomenology and constitutive equations, Maxwell model. (JAK)
Lecture 14	Rouse theory: equations of motion, normal modes, time-temperature superposition. (JAK)
Lecture 15	Diffusion & viscoelasticity, experimental tests of Rouse theory. (JAK)
Lecture 16	Zimm theory: hydrodynamic interactions, free-draining and non-draining limits, pre-averaging approximation, experimental tests. (JAK)
Lecture 17	Reptation theory: tube model; primitive chain, reptation dynamics. (JAK)
Lecture 18	The glass transition; free volume theory. (JAK)
Lecture 19	End-tethered chains: polymer brushes, self-assembly and order-disorder transitions of diblock copolymers. (JAK)
Lecture 20	Liquid crystalline polymers, polymer crystallization. (JAK)

Reference books:

The main textbook for this course is M. Rubinstein and R. C. Colby: *Polymer Physics* (Oxford University Press, 2003). Other useful references include:
(1) P.G. de Gennes: *Scaling Concepts in Polymer Physics*; (2) M. Doi and S.F. Edwards: *The Theory of Polymer Dynamics*; (3) P. Flory: *Principles of Polymer Chemistry*; (4) R. G. Larson: *Constitutive Equations for Polymer Melts and Solutions*; (5) R. G. Larson: *The Structure and Rheology of Complex Fluids*; (6) P. C. Hiemenz: *Polymer Chemistry: The Basic Concepts*. These books will be placed on reserve in the Sherman Fairchild Library.