

Introduction to Soft Condensed Matter Physics: PHY 5937

Fall 2007, Tu-Th 9:00-10:20

Instructor: Dr. Aniket Bhattacharya

Tel: 823-5206 (MAP 422)

Office Hours: Tu-Th 10:30-12:00, or by appointment

email: aniket@physics.ucf.edu

This is an introductory course on Soft Matter Systems (PHY 5937). The objective is to give an overview of a selected but very common set of soft matter systems, *e.g.*, liquid crystals, polymers, colloids, surfactants, and granular materials. An approximate course outline for a one semester course is as follows:

- **Introduction to polymers**

1. Static conformation of polymer: a single chain
2. Notion of an ideal chain: simple random walk
3. A real chain in a good solvent: a self-avoiding random walk
4. Flory exponent
5. Polymer solution in good solvent: Flory-Huggins theory
6. Polymer gels: sol-gel transition
7. Dynamics of a single polymer chain: Rouse and Zimm dynamics
8. Polymer melt and reptation dynamics.
9. Biopolymers: DNA, Electrophoretic transport of DNA
10. A brief overview of protein folding problem

- **Self-Assembly of Amphiphiles**

1. Thermodynamics of self-assembly
2. Exactly solvable simple models
3. Mean-field approaches
4. Di- and tri- block copolymers

- **Ordering in Liquid crystals**

1. Statistical mechanical models
2. Phase transitions: isotropic-nematic-smectic
3. Liquid crystals under external field

- **van der Waals interaction and forces**

1. Origin of the van der Waals interaction
2. General theory of van der Waals forces between molecules
3. Casimir effect

- **Colloidal dispersion**

1. Examples of colloidal particle in a liquid: Stokes' Law
2. Brownian motion, Fluctuation-dissipation theorem & Stokes-Einstein equation
3. Forces between colloidal particles: Casimir Effect
4. Electrostatic double-layer forces: Poisson-Boltzmann equation & Debye-Huckel theory

- **Introduction to granular materials**

Concept of temperature in granular materials; force distribution in granular materials: the q -model

Prerequisites: The prerequisite for this course is PHY 3503, or its equivalent, or by the consent of the instructor. Soft Matter Physics is a new emerging area of research. The course inherently has some interdisciplinary character. It is expected that enrollment will cover a wide spectrum of students. Therefore, the technical level will be kept at a minimum level or be taught as necessary. Emphasis will be given to a wide variety of soft matter systems.

Homework: I will assign 4-5 homework assignments

Group Assignments: There will be several group assignments; the idea is to collectively carry out relatively longer projects, which otherwise may be very time consuming. This will also facilitate students to exchange different ideas, concepts, *etc.*.

Tests: There will be one **midterm** and a **comprehensive Final**. Each student will be assigned a project, submit a research report, and make a 20-25 minutes presentation.

Grade: The final grade will be determined by the overall performance weighted in the following approximate manner:

Homework and projects - 60%, Midterm I - 20%, , Final - 20%

The final evaluation will be done by assigning a grade, *e.g.*, **A-**, **A**, **B-**, **B**, **B+**, **C-**, **C**, **C+** *etc.*.

Textbooks:

1. R. A. L. Jones, *Soft Condensed Matter*, Oxford (2002).
2. J. N. Israelachvili, *Intermolecular and surface forces*, Academic, New York (1985).

Additional References:

- P. G. de Gennes, *Scaling Concepts in Polymer Physics* (Cornell University Press, Ithaca, New York, 1979).
- M. Doi and S.F. Edwards, *The Theory of Polymer Dynamics* Clarendon Press, Oxford (1986).
- P. G. de Gennes *Physics of Liquid Crystals*, Oxford.
- M. Doi *Introduction to Polymer Physics* Clarendon Press, Oxford (1986).
- S. A. Safran, *Statistical Thermodynamics of Surfaces, Interfaces, and Membranes*, Addison Wesley, New York (1994).
- *Soft and Fragile Matter*, edited by M. E. Cates & M. R. Evans, Institute of Physics Publishing, Bristol and Philadelphia.