Rheology and Structure of Complex Fluids
06-610/09-545

Monday & Wednesday 4:30 - 5:50 p.m., WEH 5403

http://www.andrew.cmu.edu/course/06-610/

Instructor
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Office Hours: T BA

Required Text: R. G. Larson, *The Structure and Rheology of Complex Fluids*

Course Description: Complex fluids abound in practical applications and are driven by fundamentally appealing dynamics and physics. Macroscopic behavior of these fluids is controlled by the structure inherent to the fluids; so an understanding of the rheology-structure coupling is at the center of this active field of research. This course will cover the basic concepts of rheology and mechanical behavior of fluid systems. Both the experimental and theoretical aspects of rheology will be discussed. The basic forces influencing complex fluid rheology and rheology will be outlined and discussed; including excluded volume, van der Waals, electrostatic and other interactions. Methods of characterizing structure will be covered including scattering techniques, optical polarimetry and microscopy. Examples will focus on several types of complex fluids including polymer solutions and melts, gelling systems, suspensions and self-assembling fluids. **Prerequisites:** 06-609/09-509 Physical Chemistry of Macromolecules, or permission of instructor

Course Objectives and Scope: *The goal of this course is to introduce students to the exciting (and pertinent) phenomena observed in complex fluids under flow. By the end of the course, students will be introduced to, and attained skills in, the following areas:*

- Identification of the basic forces that give rise to complex fluid behavior.
- Theory behind mechanical rheometry.
- Interpretation of rheological results.
- State of the art techniques for characterization of complex fluid structure.
- Complex fluids and structure length scales in polymeric and colloidal systems.
- Basic knowledge of the physics behind polymeric systems such as: polymer solutions, block copolymers, liquid crystal polymers, polymer melts and associative thickeners.
- Basic knowledge of the physics behind colloidal systems such as: dilute suspensions, concentrated suspensions, emulsions, and yielding gels.

Grading

Midterm Project	40 %
Final Project	60 %

There will be no homework assignments or exams in this course.

Projects

Each student will complete two independent projects for this course:

1. The first will be a review of a pertinent journal article published within the last two years. This project will be due *Wednesday October 10, 2001*.
2. The second project will be more open-ended, allowing students to focus on the area of complex fluid rheology or structural characterization of the most interest to that student. This project might involve comparison of results on different systems studied in the literature, extension of a simple structural model, determination of the rheological response of a complex fluid system in a different flow field. This second project will be due towards the *end of the semester*. During *mid to late October*, we will meet individually to discuss and plan the project.

Rough Course outline and schedule

Due to traveling, I am canceling the following lectures:

M 8/27 & W 8/29 **note that this is the first week of class, so our first meeting will be on W 9/5

M 10/22 & W 10/24

W 11/7

Section I: Basics (approx. three weeks)

Complex fluids – examples, pertinent length scales, common features & applications.

Mechanical Rheology – techniques, pitfalls & interpretation of data.

Forces – basics forces that drive the dynamics and behavior – steric, van der Waals, electrostatic etc.

Section II: Polymeric Systems (approx. three weeks)

Polymer Solutions – overlap, reptation, scaling laws, nonlinear behavior.

Polymer Gels – yielding behavior, transient network models.

Section III: Suspensions (approx. three weeks)

Colloidal fluids – dilute, concentrated, filled systems.

Emulsions & Blends – interfaces, viscoelasticity, drop dynamics.

Section IV: Mesoscopic Systems (remaining time)

Self-assembling and liquid crystal systems – phases, structural characterization.

Block copolymers – structures, rheology.

This is the basic structure and it mirrors the structure of the course text. The later sections in the course will evolve based on the interests of the class.