University Of California, Berkeley
Department of Mechanical Engineering

ME 285D: Engineering Rheology (3 units)

Graduate Course

Syllabus

CATALOG DESCRIPTION

Rheology is the study of the interaction between forces and the flow/deformation of materials. It deals with aspects of the mechanics of materials that are not covered in the standard curriculum, such as the response of viscoelastic fluids and solids, together with methods for modeling and simulating their response. Such materials exhibit a host of counterintuitive phenomena that call for nonlinear modeling and a close interaction between theory and experiment. This is a special-topics course for graduate students seeking advanced knowledge of these phenomena and associated modeling.

COURSE PREREQUISITES

A basic background in continuum mechanics (as covered in ME 185).

TEXTBOOK(S) AND/OR OTHER REQUIRED MATERIAL

TBA

COURSE OBJECTIVES

To expose students to the theory and methods of modern rheology, including: the mechanics of flow in complex non-Newtonian fluids and the mechanics of viscoelastic solids.

DESIRED COURSE OUTCOMES

Skill in modeling and simulating rheological problems.

TOPICS COVERED

Rapid review of the relevant continuum mechanics; tensors describing stress, deformation and flow. Integral and differential theories for simulating the history-dependent response of materials. Relevant stress rates. Rheological data as a guide for theory development. Viscometric and elongational flows. Models based on molecular considerations. Linear and nonlinear viscoelasticity of solids. Effects of viscosity on dynamics; complex moduli; creep and relaxation functions. Examples drawn from fiber spinning, film blowing, stress analysis of polymer-based components.

CLASS/LABORATORY SCHEDULE

3 hours of lecture per week.

CONTRIBUTION OF THE COURSE TO MEETING THE PROFESSIONAL COMPONENT

Equips students with an understanding of modern rheology, a fundamental aspect of modern engineering processes.

ASSESSMENT OF STUDENT PROGRESS TOWARD COURSE OBJECTIVES

Homework = 75%
Course project (no final) = 25%

TOPICS COVERED

1. Review of the necessary pre-requisites from Continuum Mechanics: Relative deformation measures, tensors describing stress, deformation and flow; Rivlin-Ericksen tensors.
2. Viscometric and elongational flows in viscoelastic fluids; large deformations with small strains.
3. Comparison of theory and experimental data; counter-intuitive behavior of viscoelastic fluids.
4. Microstructural models and models based on molecular considerations.
5. Lubrication theories and coating flows.
6. Fiber spinning and film blowing.
7. Effects of pressure and temperature.
8. Viscoelastic solids. Nonlinear integral and rate theories.
9. Classical linear theory; relaxation and compliance moduli; frequency response, complex moduli and compliance; the Correspondence Principle.

PERSON(S) WHO PREPARED THIS DESCRIPTION
Professor David Steigmann, August 16, 2013

ABBREVIATED TRANSCRIPT TITLE (19 SPACES MAXIMUM): ENG RHEOLOGY
TIE CODE: LECT
GRADING: Letter
SEMESTER OFFERED: Fall and/or Spring
COURSES THAT WILL RESTRICT CREDIT: None
INSTRUCTORS: Steigmann
DURATION OF COURSE: 15 Weeks
EST. TOTAL NUMBER OF REQUIRED HRS OF STUDENT WORK PER WEEK: 9
IS COURSE REPEATABLE FOR CREDIT? Yes
CROSSLIST: None