University Of California, Berkeley
Department of Mechanical Engineering

ME 185 – Introduction to Continuum Mechanics (3 units)

Undergraduate Elective

Syllabus

CATALOG DESCRIPTION:

This course is a general introduction to the fundamental concepts of the mechanics of continuous media. Topics covered include the kinematics of deformation, the concept of stress, and the conservation laws for mass, momentum and energy. This is followed by an introduction to constitutive theory with applications to well-established models for viscous fluids and elastic solids. The concepts are illustrated through the solution of tractable initial-boundary-value problems. This course presents foundation-level coverage of theory underlying a number of sub-fields, including Fluid Mechanics, Solid Mechanics and Heat Transfer.

COURSE PREREQUISITES:

Physics 7A, Math 53 and Math 54, some prior exposure to the elementary mechanics of solids and fluids.

TEXTBOOK(S) AND/OR OTHER REQUIRED MATERIAL:

P.M. Naghdi's Notes on Continuum Mechanics (to be posted on Bcourses); P. Chadwick, Continuum Mechanics: Concise Theory and Problems. Dover, N.Y. 1976; M.E. Gurtin. An Introduction to Continuum Mechanics. Academic Press, N.Y., 1981.

COURSE OBJECTIVES:

This course is designed for students of Solid Mechanics and Fluid Mechanics. Its purpose is to equip students with a rigorous foundation-level understanding to support their efforts in the theory, modeling and analysis of problems arising in the Engineering Sciences.

DESIRED COURSE OUTCOMES:

Students will gain a deep understanding of the concepts and methods underlying modern continuum mechanics. The course is designed to equip students with the background needed to pursue advanced work in allied fields.

TOPICS COVERED:

Mathematical preliminaries: Linear spaces, vectors and tensors in Euclidean spaces, tensor algebra and calculus; Kinematics of deformation: Bodies, configurations, motions, mass and density, deformation gradient and its polar decompositions, rotation and stretch strain measures, velocity gradient, stretching and vorticity tensors, rigid-body motions, Reynolds' transport theorems; Physical principles: Mass conservation, definition of forces, balance of linear momentum and moment of momentum, traction vector and stress tensor, local equations of motion, alternative stress measures, change of frame and transformations under superposed rigid-body motions, balance of energy; Constitutive theory: Invariance requirements and other restrictions on constitutive equations, constraints, viscous and inviscid fluids, elastic solids, linearization of elasticity theory and associated kinematics.

CLASS/LABORATORY SCHEDULE:

3 hours of lecture/week, 1 hour discussion/week, 4-5 hours of homework/week, 2 in-class midterm exams, 1 3-hour final exam scheduled during final exam period.

CONTRIBUTION OF THE COURSE TO MEETING THE PROFESSIONAL COMPONENT:

The course equips students with the knowledge and tools necessary to model and analyze a very wide range of problems in the Engineering and Applied Sciences. It provides students with a firm foundation for a thorough understanding of existing developments in these areas and for extending them in response to the emerging needs and demands of the engineering profession.

RELATIONSHIP OF THE COURSE TO ABET PROGRAM OUTCOMES

(a) an ability to apply knowledge of mathematics, science, and engineering,

(e) an ability to identify, formulate, and solve engineering problems,

(g) an ability to communicate effectively,

(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context,

(i) a recognition of the need for, and an ability to engage in life-long learning,

(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

ASSESSMENT OF STUDENT PROGRESS TOWARD COURSE OBJECTIVES

20%: 12 homework assignments
40%: 2 midterm exams
40%: final exam

NOTES

This course will be roomshared with ME 287. Grading for ME 185 will exempt students from homework and exam problems marked with an asterisk (which would be for ME 287, the roomshare). However, these may be attempted for extra credit. Graduate students in the course will be given approximately 20% more work in terms of homework for this course.

SAMPLE OF WEEKLY AGENDA

Week 1	Mathematical preliminaries: Linear spaces, vectors and tensors in Euclidean spaces.
Week 2	Tensor algebra and calculus
Week 3	Kinematics of deformation: Bodies, configurations, motions, mass and density
Week 4	Deformation gradient and its polar decompositions, rotation and stretch, strain measures
Week 5	Velocity gradient, stretching and vorticity tensors, rigid-body motions, Reynolds' transport theorems, Midterm # 1
Week 6	Physical principles: Mass conservation, definition of forces

Week 7	Balance of linear momentum and moment of momentum
Week 8	Traction vector and stress tensor, local equations of motion
Week 9	Alternative stress measures, power-conjugate stress and deformation measures
Week 10	Change of frame and transformations under superposed rigid-body motions
Week 11	Balance of energy, Midterm # 2
Week 12	Constitutive theory, invariance requirements and other restrictions on constitutive equations, constraints and their effects
Week 13	Viscous and inviscid fluids
Week 14	Elastic solids, linearization of elasticity theory and associated kinematics
Week 15	RRR: Review Session (Instructor or GSI)
Week 16	Final Week: Comprehensive Final Exam

PERSON(S) WHO PREPARED THIS DESCRIPTION
[David Steigmann] [March 7, 2018]

WEEKLY SCHEDULE OF TOPICS:

See weekly agenda above.

ABBREVIATED TRANSCRIPT TITLE (19 SPACES MAXIMUM): INTRO CONTINUM MECH
TIE CODE: LECT
GRADING: Letter
SEMESTER OFFERED: Fall and Spring
COURSES THAT WILL RESTRICT CREDIT: None
INSTRUCTORS: Casey, Johnson, Papadopoulos, Steigmann
DURATION OF COURSE: 15 Weeks
EST. TOTAL NUMBER OF REQUIRED HRS OF STUDENT WORK PER WEEK: 9 Hours
IS COURSE REPEATABLE FOR CREDIT? No.
CROSSLIST: