

University Of California, Berkeley
Department of Mechanical Engineering

ME C176: Orthopedic Biomechanics (4 units)

Elective Course

Syllabus

CATALOG DESCRIPTION

Students will learn the application of engineering concepts including statics, dynamics, optimization theory, composite beam theory, beam-on-elastic foundation theory, Hertz contact theory and materials behavior. Topics will include forces and moments acting on human joints; composition and mechanical behavior of orthopedic biomaterials; design/analysis of artificial joint, spine, and fracture fixation prostheses; musculoskeletal tissues including bone, cartilage, tendon, ligament, and muscle; osteoporosis and fracture-risk prediction of bones; and bone adaptation. Students will be challenged in a MATLAB-based project to integrate the course material in an attempt to gain insight into contemporary design/analysis/problems. Also listed as Bioengineering C119.

COURSE PREREQUISITES

ME C85, CE C30, or BIOE 102, or equivalent; concurrent enrollment OK. Proficiency in MatLab or equivalent. Prior knowledge of biology or anatomy is not assumed.

TEXTBOOK(S) AND/OR OTHER REQUIRED MATERIAL

Bartel DL, Davy DT, and Keaveny TM: *“Orthopaedic Biomechanics: Mechanics and Design in Musculoskeletal Systems”* Pearson Prentice Hall, New Jersey, 2006.

COURSE OBJECTIVES

The purpose of this course is twofold:

- to learn the fundamental concepts of orthopaedic biomechanics;
- to enhance skills in mechanical engineering and bioengineering by analyzing the mechanical behavior of various complex biomedical problems.

DESIRED COURSE OUTCOMES

Working knowledge of various engineering concepts such as composite beam theory, beam-on-elastic-foundation theory, Hertz contact theory and MATLAB-based optimization design analysis. Understanding of basic concepts in orthopaedic biomechanics and the ability to apply the appropriate engineering concepts to solve realistic biomechanical problems, knowing clearly the assumptions involved.

TOPICS COVERED

Basic anatomy, Static analysis of skeletal systems, Kinematics and dynamics, Viscoelasticity, Tissue Mechanics, Muscle Mechanics, Composite beam theory, Whole Bone Structural Analysis, Mechanics of aging, disease, drug treatment; Implant Design: Orthopaedic implant materials, Design objectives of orthopaedic

prostheses, Design of hip prostheses, Beam-on-elastic-foundation theory, Contact stresses and wear, Design of knee prostheses, Fracture fixation and spinal implants, Bone adaptation and implant design.

CLASS/LABORATORY SCHEDULE

Three hours lecture, and one hour lab/computer workshop per week.

CONTRIBUTION OF THE COURSE TO MEETING THE PROFESSIONAL COMPONENT

Emphasis on interpretation of results from analytical and computational models, in light of economic, ethical and safety issues provides students with substantial professional component. Students are also required to write professional-type short reports summarizing their computational analyses.

RELATIONSHIP OF THE COURSE TO ABET PROGRAM OUTCOMES

An ability to apply knowledge of mathematics, science, and engineering. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability. An ability to identify, formulate, and solve engineering problems. An ability to communicate effectively. A recognition of the need for, and an ability to engage in life-long learning. A knowledge of contemporary issues. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

ASSESSMENT OF STUDENT PROGRESS TOWARD COURSE OBJECTIVES

The students' progress is assessed via Weekly homework, three Matlab assignments which involves computer programming, one Mid-term exam and a Final exam 40%

ROOM SHARE AND GRADUATE CONTENT

In the graduate level version of Orthopaedic Biomechanics, graduate students will review current work in the literature that applies the principles and techniques described in class. There will be a separate discussion section for the graduate students to discuss these papers. Also, these sessions will provide the students with a broad understanding of the cutting edge research being performed in this area. By the end of the semester, it is expected that the students will not only be able to read and understand the literature, but will be able to critically assess the limitations, strengths and weaknesses in a study.

A second major component difference between the undergraduate and graduate level course work will be a written assignment with an oral presentation. The graduate students will be expected to provide an oral presentation to the class (groups of 3). Students will describe an anatomical feature and a condition or disease associated with the feature. In addition, the group will be required to write a short summary report of the anatomical region with the focus of expressing to a lay reader why it is important to know about the feature/condition, what's being done research-wise or clinically, and what future treatments may be coming. It is expected that this assignment will allow them to apply the critical thinking skills learned during the discussion sections, described above. The purpose of this assignment is not for the students to feel like they need to solve these big issues in one assignment, but more to focus on communicating these ideas to people that may not know the topic area (i.e. general public or other engineers).

PERSON(S) WHO PREPARED THIS DESCRIPTION:

Tony Keaveny, Feb. 26, 2006. Updated June 18, 2009.

Professor Grace O'Connell, September 25, 2013

ABBREVIATED TRANSCRIPT TITLE (19 SPACES MAXIMUM): Ortho Biomech

TIE CODE: LECS

GRADING: Letter

SEMESTER OFFERED: Fall, Spring

COURSES THAT WILL RESTRICT CREDIT: None

INSTRUCTORS: Professor Tony Keaveny

DURATION OF COURSE: 15 weeks

EST. TOTAL NUMBER OF REQUIRED HRS OF STUDENT WORK PER WEEK: 12

IS COURSE REPEATABLE FOR CREDIT? No

CROSSLIST: Bio Engineering C119

ROOMSHARE: Bio Engineering C209/Mechanical Engineering C210