

ME C176, BIO ENG C119 (4 units) Fall 2009
“Orthopaedic Biomechanics”
UC Berkeley Departments of Mechanical Engineering and Bioengineering

Professor Tony M. Keaveny, 6175 Etcheverry Hall tmk@me.berkeley.edu
 Office Hours: TU 10:00–11:30 AM; W 4:00–5:30 PM

Graduate Student Instructor: Aaron Fields: afields@me.berkeley.edu
 Office Hours: W 1:00–2:00 PM, TH 9:00–10:00 AM; Hesse Hall Rm. 136

URL: www.me.berkeley.edu/ME176
 Class email: me176-class@me.berkeley.edu (to subscribe, send an email to majordomo@me.berkeley.edu with “subscribe me176-class your@email.com” in the body of the message)

Prerequisites: CE 130 or BIOE 102 (concurrent enrollment acceptable); or equivalent.

Working knowledge of MATLAB is required. Prior knowledge of biology or anatomy is not assumed. Open for undergraduates and graduates.

Lectures: TU TH 12:30–2:00 PM; 3107 Etcheverry Hall.

Discussion: M 9:00–10:00 AM, W 12:00–1:00 PM; 2105 Etcheverry Hall.

Computer Lab: 2105 Etcheverry Hall.

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

CC #: ME: 55965; BIO ENG: 07152

COURSE DESCRIPTION

From a biomechanical perspective, the healthy human skeleton is an optimal structure that has adapted its form in response to its function. Studying the mechanics of the skeleton therefore provides information that can be used not only to design artificial prostheses and materials — and thus address specific health care issues — but also to aid in the design of more traditional engineering structures by understanding the behavior and underlying design features of this complex dynamic structure. Thus, 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.

Examples of engineering concepts that will be used include statics, dynamics, optimization theory, composite beam theory, beam-on-elastic-foundation theory, Hertz contact theory, and materials behavior. The course has three main themes: Skeletal Forces and Motion; Tissue and Organ Mechanics; and Implant Design and Analysis. Specific biomechanics topics will include loads on human joints; dynamic analysis of human motion; mechanical properties of musculoskeletal tissues including bone, cartilage, tendon, ligament, and muscle; osteoporosis fracture-risk prediction of bones; mechanics of bone adaptation; composition and mechanical behavior of orthopaedic biomaterials; and design/analysis of artificial joint, spine, and fracture fixation prostheses. Students will be challenged with a MATLAB-based course project to integrate the course material in an attempt to gain insight into contemporary design/analysis problems, which will be prefaced by simpler MATLAB-based and analytical biomechanics assignments. The course is ideal for those interested in biomechanical engineering, including those wishing to further develop technical skills in mechanical engineering, and those interested in addressing contemporary engineering design and analysis problems of societal relevance.

<i>Grading:</i>	Weekly homeworks	10%
	Matlab assignments (2 + course project)	30% (2.5+7.5+20.0)
	Mid-term exam	20%
	Final exam	40%

DATE	LECTURE TOPIC	MATLAB	READING
<i>Skeletal Forces and Motion</i>			
Aug. 27	Introduction; basic anatomy		2–21
Sep. 1	Static analysis of skeletal systems I		23–35
Sep. 3	Static analysis of skeletal systems II		
Sep. 8	The force distribution problem		35–44
Sep. 10	Kinematics and dynamics I*		44–58
Sep. 15	Kinematics and dynamics II*		64–65
Sep. 17	Joint stability	MTLB 1 (due 10/01)	58–64
<i>Tissue and Organ Mechanics</i>			
Sep. 22	Viscoelasticity I		154–163
Sep. 24	Viscoelasticity II*		
Sep. 29	Tissue mechanics I		71–116
Oct. 1	Tissue mechanics II		121–147
Oct. 6	Muscle mechanics		147–153; 163–164
Oct. 8	MID-TERM EXAM		
Oct. 13	Composite beam theory (Symmetric beams)		168–176
Oct. 15	Composite beam theory (Unsymmetrical beams)	MTLB 2 (due 10/29)	177–182
Oct. 20	Impact biomechanics		
Oct. 22	Case studies: whole bone mechanics		183–198
<i>Implant Design and Analysis</i>			
Oct. 27	Orthopaedic implants: materials		235–245
Oct. 29	Orthopaedic implants: design objectives		245–259
Nov. 3	Design of hip prostheses		290–304; 310
Nov. 5	Design of spine and fracture fixation prostheses	Project (Part A, due 11/19)	261–287
Nov. 10	Beam-on-elastic-foundation theory I		203–213
Nov. 12	Beam-on-elastic-foundation theory II		304–310
Nov. 17	Articulating surfaces		223–231; 335–349
Nov. 19	Design of knee prostheses	Project (due 12/08)	314–332
Nov. 24	Regulatory issues		
Nov. 26	THANKSGIVING HOLIDAY		
Dec. 1	Project discussion		
Dec. 3	Patents and inventions; translational issues		
Dec. 8	Review (optional lecture)		
Dec. 18	FINAL EXAM, 12:30–3:30 PM, Location TBA.		

* Lecture by Aaron Fields