University Of California, Berkeley
Department of Mechanical Engineering

ME 178: Designing for the Human Body (3 units)

Undergraduate Course

Syllabus

CATALOG DESCRIPTION

The course provides project-based learning experience in understanding product design, with a focus on the human body as a mechanical machine. Students will learn the design of external devices used to aid or protect the body. Topics will include forces acting on internal materials (e.g., muscles and total replacement devices), forces acting on external materials (e.g., prothetics and crash pads), design/analysis of devices aimed to improve or fix the human body, muscle adaptation, and soft tissue injury. Weekly laboratory projects will incorporate EMG sensing, force plate analysis, and interpretation of data collection (e.g., MATLAB analysis) to integrate course material to better understand contemporary design/analysis/problems. The final group project will challenge students to design a human body-interfacing product based on the course material covered throughout the semester.

COURSE PREREQUISITES

Proficiency in MatLab or equivalent. Prior knowledge of biology or anatomy is not assumed. Physics 7A, Math 1A and 1B.

NO TEXTBOOK(S) AND/OR OTHER REQUIRED MATERIAL

A list of recommended texts will be available on reserve at the library.

COURSE OBJECTIVES

The purpose of this course is twofold:

- to learn the fundamental concepts of designing devices to interact with the human body;
- to enhance skills in mechanical engineering and bioengineering by analyzing the behavior of various complex biomedical problems;
- To explore the transition of a device or discovery as it goes from “benchtop to bedside”.

DESIRED COURSE OUTCOMES

Working knowledge of design considerations for creating a device to protect or aid the human body, force transfer and distribution, data analysis, and FDA approval process for new devices. 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. Critical analysis of current literature and technology.

TOPICS COVERED

Basic anatomy, Muscle Mechanics, Sensors for measuring tissue function (internal and external) (EMG/Force plate experiments), Disease and Drug Treatment effects, Design objectives of external devices, passive external device design (e.g. braces, prothetics), active prosthetic devices (e.g., connection to brain impulses), Contact stresses and wear, implantation and failure.

CLASS/LABORATORY SCHEDULE

Three-hour lecture and lab (time of the lab depends on the topic for the week). The total time in class/lab each week should be about 3 hours.

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 required to write professional-type short reports summarizing their computational analyses. Students are required to provide a brief oral presentation to discuss the etiology and epidemiology associated with part of the anatomy. Students will also be required to write a professional review-type summary of the literature that has improved our basic understanding of biomechanics.

RELATIONSHIP OF THE COURSE TO ABET PROGRAM OUTCOMES

(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(d) an ability to function on multi-disciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(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
(j) a knowledge of contemporary issues
(k) 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 workshop assignments, three mini-projects, which involves computer programming, one oral presentation, one literature review paper, one Mid-term exam and a Final project. All projects are group-based projects.

TOPICS COVERED/WEEKLY AGENDA

	Laboratory workshop topic	**Assignments/ Mini Projects (due)**
Week 1	Introduction; basic anatomy	

Week 2	Analysis of forces placed on the body (external and external)	
Week 3	Measure muscle output - emg laboratory assigment	
Week 4	Sensors for measuring tissue function (internal and external)	Project 1
Week 5	Internal changes on external function (disease and drug treatment effects)	
Week 6	Design objectives of external devices	
Week 7	Midterm	Project 2
Week 8	Passive external device design and performance	
Week 9	Active external device design and performance	
Week 10	Contact, wear and failure	Project 3
Week 11	Fda process and approval	
Week 12	Current advancements technology and wearables based on covered topics	
Week 13	Final project presentations	
Week 14	No discussion	Final project
Week 15		

FINAL PROJECT DESCRIPTION

The final project will involve researching a topic area of interest to the students that would involve creating a device that would interact with the body. Throughout the semester students will learn about design criteria for developing external devices to interact with the human body. For example, a series of workshop assignments involves measuring muscle forces through an EMG sensor. Students will also learn about new research to control devices through muscle/brain interactions. Therefore, an example of a final project may be the design of a wearable device that senses muscle interaction either to deliver a drug if the readout is above a certain level or to send a message to the user wearing the device. Students will need to identify what information would need to be gathered and how it would be interpreted before a building a prototype. They should also be able to identify what steps, if any, would be needed for FDA approval of a new device.

Final projects will be written reports drawing from the experiments and lecture throughout the semester. The final project is group-based work and the group will be required to give an oral presentation at the end of the semester.

All weekly laboratory/workshop assignments are group-based.

ASSESSMENT OF STUDENT PROGRESS TOWARD COURSE OBJECTIVES

Weekly Homeworks	15%
Mini-Project	25%
Mid-term exam	20%
Final Project	40%

PERSON(S) WHO PREPARED THIS DESCRIPTION

Dr. Grace O'Connell, September 22, 2015.

ABBREVIATED TRANSCRIPT TITLE (19 SPACES MAXIMUM): DES HUMAN BODY
TIE CODE: LECS
GRADING: Letter
SEMESTER OFFERED: Spring
COURSES THAT WILL RESTRICT CREDIT: None
INSTRUCTORS: Prof. O'Connell
DURATION OF COURSE: 15 Weeks
EST. TOTAL NUMBER OF REQUIRED HRS OF STUDENT WORK PER WEEK: 9
IS COURSE REPEATABLE FOR CREDIT? No
CROSSLIST: BioE in future