University of California, Berkeley
Department of Mechanical Engineering

ME 179 – Augmenting Human Dexterity (4 units)

Undergraduate Elective

Syllabus

CATALOG DESCRIPTION
This course provides hands-on experience in designing prostheses and assistive technologies using user-centered design. Students will develop a fundamental understanding of the state-of-the-art, design processes and product realization. Teams will prototype a novel solution to a disabilities-related challenge, focusing on upper-limb mobility or dexterity. Lessons will cover biomechanics of human manipulation, tactile sensing and haptics, actuation and mechanism robustness, and control interfaces. Readings will be selected from texts and academic journals available through the UCB online library system and course notes. Guest speakers will be invited to address cutting edge breakthroughs relevant to assistive technology and design.

COURSE PREREQUISITES
ME 132, or equivalent. Designing for the Human Body (ME C178) or Orthopedic Biomechanics (ME C176), or equivalent. Proficiency with Matlab, or equivalent program.

TEXTBOOK(S) AND/OR OTHER REQUIRED MATERIAL
Jones, Lynette A., and Susan J. Lederman. Human hand function. Oxford University Press, 2006.
Jacobs Hall Makerpass, access to CAD software (e.g. Solidworks, Fusion 360, etc.) and MATLAB.

COURSE OBJECTIVES
The course objectives are to:
- Learn the fundamental principles of biomechanics, dexterous manipulation, and electromechanical systems relevant for non-invasive, cutting-edge assistive device and prosthesis design
- Enhance skill in the areas of human-centered design, teamwork and communication through the practice of conducting labs and a project throughout the semester

DESIRED COURSE OUTCOMES
By the end of the semester, students will have a working knowledge of the design process and will have experience taking a project from conceptualization to end result. Given that the course is centered around assistive technology, during the design process they learn to collaborate with a need-knower. They will learn brainstorming techniques and exercise rapid prototyping skills. Student will be supported to present their projects clearly and concisely and gain feedback through design reviews. Ultimately, students will understand how the human hands and arms function, and the current state of the field in upper-limb prosthesis and assistive device technology.

TOPICS COVERED
(1) Overview the functions of human hands and arms, including bimanual manipulation, (2) history of hand and arm injuries and disabilities and current assistive technologies, (3) overview of artificial dexterous manipulation with a focus on the fundamental challenges of embodied design, (4) human tactile sensing, haptics, motor control, and neural interface technology (5) lessons in applied mechatronic systems, like sensors and actuators for hands and arms, (6) the human centered design process with case studies in assistive technology and prosthetics, (7) how to work in teams, communicate ideas effectively, and market innovations.

CLASS/LABORATORY SCHEDULE
Two lectures and one laboratory section per week.

CONTRIBUTION OF THE COURSE TO MEETING THE PROFESSIONAL COMPONENT
Interpretation of prototypes and results from analysis and experimentation. Economic, ethical, and safety considerations relating to assistive devices. Need-finding from "need-knowers." Professional communication, including visual, verbal, and written forms. Consuming and producing scientifically relevant work.

RELATIONSHIP OF THE COURSE TO ABET PROGRAM OUTCOMES

(a) an ability to apply knowledge of mathematics, science, and engineering
(c) 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
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(j) a knowledge of contemporary issues

ASSESSMENT OF STUDENT PROGRESS TOWARD COURSE OBJECTIVES

25% Homework & Laboratories
25% Exam
50% Project

SAMPLE OF WEEKLY AGENDA

Week 1	Introduction, Prosthetist guest speaker
Week 2	Biomechanics of hands and arms
Week 3	Robotic manipulators and end effectors (kinematics and actuation)
Week 4	Body and Machine: state of the art / scientific paper reading
Week 5	Tactile sensing: body and machine
Week 6	Haptic feedback: body and machine / Tele-operation
Week 7	Project initiation / Interview etiquette and practice
Week 8	Guided design practice / design review #1
Week 9	User inputs / EMG
Week 10	Case studies with guest speakers
Week 11	Design review #2 / scientific paper writing
Week 12	Current hot topic: Soft wearable devices (SoRo) in industrial assistance
Week 13	Current hot topic: Commercializing assistive tech
Week 14	Project presentations
Week 15	RRR / Jacobs Design Showcase
Week 16	Finals Week

ROOM SHARE AND GRADUATE CONTENT
The graduate-level version of the course will have a stronger emphasis on scientific method and advanced modeling techniques, as compared with the undergraduate-level course sharing the same room. Homework and

laboratory assignments will each include additional challenge questions required only for graduate students. Graduate students will also be in smaller project groups and receive a more demanding grade rubric: they will be asked to provide a more thorough background/works-cited section, develop a more advanced device model, and critically propose future work beyond their undergraduate counterparts.

ADDITIONAL NOTES
This course in intended to include DESINV students as well as MECENG students. DESINV students will be assessed with a different set of prerequisites as compared to the MECENG students for course admission.

PERSON(S) WHO PREPARED THIS DESCRIPTION
[Hannah Stuart] [3/5/2019]

ABBREVIATED TRANSCRIPT TITLE (19 SPACES MAXIMUM): [AUG HUMAN DEXTERITY]
TIE CODE: [LECS]
GRADING: Letter
SEMESTER OFFERED: Fall and/or Spring
COURSES THAT WILL RESTRICT CREDIT: ME 270
INSTRUCTORS: Hannah Stuart
DURATION OF COURSE: 15 Weeks
EST. TOTAL NUMBER OF REQUIRED HRS OF STUDENT WORK PER WEEK: 12
IS COURSE REPEATABLE FOR CREDIT? No
CROSSLIST: None