

Upper-Limb Prosthesis Design

Fall 2018 (4 units)

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 non-invasive solution to a disabilities-related challenge, focusing on upper-limb mobility or dexterity. Lessons will cover biomechanics of manipulation, tactile sensing and haptics, actuation and mechanism robustness, and control interfaces. Readings will be selected from academic journals and course notes. Guest speakers will be invited to address cutting edge breakthroughs relevant to assistive tech. Students from a diverse set of technical backgrounds are encouraged, but should have some type of engineering experience. A brief survey during the first class will help the teaching staff determine enrollment into the course.

We will be using bCourses for the course website, <https://bcourses.berkeley.edu/>

Teaching Team Professor Hannah Stuart (hstuart@berkeley.edu)
Office Hours: Fri 9-10:30am, 5138 Etcheverry Hall

Drew McPherson, M.S. (drewmcperson25@berkeley.edu)
Office Hours: Mon 2-4pm, Jacobs Hall, 310D

GSI Monica Li, M.S. (monicasli@berkeley.edu)

Lectures/Lab Lecture: Mon, Wed 12:30-2:00 Jacobs Hall, 210
Lab: Fri 1:00-4:00 Jacobs Hall, 220

Availability for lectures, laboratories, midterm and project presentations is required for enrollment in the class. This course includes in-class exercises, many of which require team cooperation. Please see the teaching team for accommodation of religious beliefs, disabilities, and other special circumstances ***before the end of the second week of classes*** for any foreseeable issues.

Required Course Materials:

Software: Autodesk Fusion 360 (or SolidWorks), Matlab, Arduino IDE

Laptop: At least 1 required for each lab group

Equipment: Jacobs Hall Makerpass

Text: Posted readings on bcourses and ebooks via Berkeley Library

Project Cost: TBD

Scoring: 25% Homework and laboratories
15% Midterm Exam
15% Individual Project
45% Team Project

Projects:

Individual project – There are two primary components. (1) Background research into one particular topic relating to upper-limb prosthesis, orthosis, or assistive tech. (2) A proposal for an innovative device or research project.

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Team project – There will be a final term project in which teams of no more than 4 students will apply what they have learned through lecture and lab to design and prototype a novel improvement to the current state of upper extremity prosthetics. *The instructors will ultimately determine teaming.*

Participation and Peer-evaluations

Participation is central to this class. Therefore, your final grade may be marked down by up to 3% for every lecture or laboratory missed without prior instructor approval. Peer-evaluations will be performed for each project. You will evaluate yourself, as well as peers in your team and other groups. *These evaluations will be factored into your grade.* No display of activity on your project can result in individual project grade reductions of up to 100% in the most extreme cases.

Academic Honesty and Integrity:

The student community at UC Berkeley has adopted the following Honor Code: "As a member of the UC Berkeley community, I act with honesty, integrity, and respect for others." For homework assignments in this class, you are allowed (and encouraged!) to *discuss* the problems and techniques with other students currently in this course, but each student must do his or her own version of the solution *from scratch*.

Cheating on a midterm may result in a failing grade for the entire course. In all cases, your actions will also be reported to the Center for Student Conduct for administrative review.

Jacobs Hall

As part of this course and your Makers Pass, you can gain access to the equipment within Jacobs Hall. In order to use the equipment you will need to take (and pass) the safety requirements.

<http://jacobsinstitute.berkeley.edu/our-space/makerpass/get-maker-pass/>

How to get a Maker Pass

1. *Training:* New users must pass the General Workshop Safety (GWS) training; trainings from past semesters carry over, so if you passed GWS last semester, you do not need to retake it, unless it is deemed necessary by Jacobs staff, on a case-by-case basis.

2. *Fees:* The Jacobs Hall Maker Pass fee is \$75 for the semester, payable by credit card via an online form, or check made out to "UC Regents," brought to 234 Jacobs Hall. Fee waivers are available to students with financial need as an option within the Maker Pass application. For more information email mail jacobsinstitute@berkeley.edu

WEEKLY AGENDA:

Week	Topic	Lecture/Lab
Week 1 8/20/18	Intro prostheses and assistive tech	M. No Class
		W. Intro, interest, logistics
		F. Tour of Jacobs / Intro course tools (optional)
Week 2 8/27/18	Biomechanics of manipulation	M. State of art, Hand and wrist biomechanics
		W. Prosthetician, guest lecture
		F. Lab 1: Biomechanics and single finger setup
Week 3 9/3/18	Grasping and manipulation theory	M. Labor Day
		W. Grasping and manipulation in robotics
		F. Lab 2: Actuated grasping, prototyping

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Week 4 9/10/18	Compliance and tactile sensing	M. Compliant mechanics
		W. Tactile sensing
		F. Lab 3: Tactile sensing lab
Week 5 9/17/18	Haptic feedback	M. Socket design
		W. Haptic feedback and sockets
		F. Lab 4: Haptics lab
Week 6 9/24/18	Neural control	M. Haptics, signal processing
		W. Neural inputs, EMG soft electronics
		F. Lab 5: EMG control
Week 7 10/1/18	Human-centered design in teams	M. Human-centered design
		W. Teaming in design, Intellectual property
		F. Lab 6: Exercising the design process
Week 8 10/8/18	Human-centered design case studies	M. No Class Columbus Day
		W. Prosthesis case studies
		F. First team work session
Week 9 10/15/18	Mechatronic Design	M. Power management
		W. Signal processing
		F. Lab 7: Power management lab
Week 10 10/22/18	Design review	M. Student selected topic, TBD
		W. Guest lecture, TBD
		F. First Design Review
Week 11 10/29/18	Communication, marketing assistive tech	M. Basics of marketing
		W. Student selected topic, TBD
		F. Project Work Session
Week 12 11/5/18	Intro to lower-limb technologies	M. FDA and case study
		W. Guest lecture, TBD
		F. Design Reviews
Week 13 11/12/18	Projects	M. No Class, Veterans Day
		W. Public speaking / slide making
		F. Project Work Session
Week 14 11/19/18	Projects	M. Student selected topic, TBD
		W. No Class, Thanksgiving
		F. No Class, Thanksgiving
Week 15 11/26/18	Project presentations	M. Project Work Session
		W. Project Work Session
		F. Class Oral Presentations
Week 16 12/3/18	RRR Week	M. No Class
		W. Public Demonstration
		F. No Class

* Notes: *This syllabus is a guide and every attempt is made to provide an accurate overview of the course. However, circumstances and events may make it necessary for the instructors to modify the syllabus during the semester and may depend, in part, on the progress, needs, and experiences of the students. Changes to the syllabus will be made with advance notice.*