ENME 289P - Special Topics: Additive manufacturing for Prosthetic Design (2 credit)

Department of Mechanical Engineering

Spring 2019 Syllabus

Meeting Times

Lecture: M 5:00-7:00pm

Studio: W 5:00-6:00pm

Prerequisites: ENME 272 or CAD experience

Textbook

This class does NOT have a required textbook. All lecture slides will be posted on ELMS for your reference. The slides are to be used in lieu of a textbook, and are thus filled with extra information and useful links.

Course Description

This project-oriented course is designed to provide students an introduction to prosthetic design while empowering them to take advantage of the vast 3D printing resources at the University of Maryland to create and test a unique prosthetic prototype. The course will cover prosthetic components and design considerations, as well as the basics of 3D printing, before delving into the interface between the two subjects.

Course Instructor

Angie Bryl, CPO (abryl@dankmeyer.com) Office Hours TBD

Undergraduate Teaching Fellows

Saul Schaffer (saul@umd.edu) Office Hours TBD

Anna Packy (apacky@umd.edu) Office Hour TBD

Topics Covered

- Introduction to consumer and industrial 3D printing
- Types of commercially available prosthetic components
- Amputee functional mobility levels
- Recent advancements in prosthetic design
- Considerations regarding designing unique devices without delaying patient care
- Working with prosthetists as an engineer
    - How prostheses and prosthetic components are currently manufactured
    - Designing around manufacturing choke points
- Testing protocols for prosthetic components

Learning Outcomes

In addition to the topics covered, this course is designed to provide the students with the following ABET originated student 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.
(c) An ability to design a system, component, or process to meet desired needs within realistic constraints.
(g) An ability to communicate effectively.
(j) A knowledge of contemporary issues.
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Assessment

1. Attendance/Participation: 25%
2. Assignments and Exercises: 10%
3. Midterm project: 20%
4. Final project: 45%

Grades will be regularly updated on ELMS.

Attendance

Attendance/participation grade will be based upon attending both lecture and studio sessions, engaging in class discussions, and asking questions. Short participation assignments or quizzes will be used to help gauge student involvement and grasp of the material. When computing grades, the lowest participation-quiz grade will be dropped.

Assignments and Exercises

Homework assignments will include viewing Lynda.com videos and producing initial 3D prints through Terrapin Works. The purpose of these exercises are to familiarize the student with additive manufacturing, CAD design, and practice printing in preparation for the midterm and final projects.

Midterm and Final Projects

As this is a project based course, the bulk of the work will be focused on a semester-long project concerning the use of additive manufacturing to better address the growing needs of the amputee population for fast, affordable, custom devices. The project will consist of two parts: 1) the initial prototype design and testing (midterm), and 2) the revised prototype and presentation (final). For more information, see Project Description document.

The midterm project will involve designing and producing an initial 3D printed prototype of a prosthetic foot, using a Makerbot 3D printer at Terrapin Works. Testing and data collection on this prototype will be done during studio time. The data will then be analyzed and used to refine the prototype for the final project. The final project grade will be based on the final 3D printed design, as well as a short demonstration video produced by the student. Additional details regarding the project will be given in class.

Projects must be submitted in-person, printed. Project files cannot be submitted through email as a replacement for physical models. Students are welcome to attend office hours with questions on implementation, design, and feasibility, if students wish. Projects may be turned in early but will not be accepted late, as the official testing and presentation of the printed projects will occur during specified

lab time. If there are extenuating circumstances, discuss with the instructor prior to the due date and alternate arrangements may be made. For medically necessitated excuses, supporting documentation signed by a doctor or health-care professional is required, in addition to timely notice.

Academic Integrity

University of Maryland policies on Academic Integrity will be strictly enforced. All assignments and projects submitted for evaluation must be original work, unless otherwise specified by the instructor. Policies relevant to Undergraduate Courses, including academic integrity, student and instructor conduct, accessibility and accommodations, and attendance and excused absences are found here: http://www.ugst.umd.edu/courserelatedpolicies.html

Spring 2018 Schedule - TENTATIVE:

Week	Date	Lecture Topic	Lab Content	Assignments
1	Jan 29	Overview of course & Introduction to Additive Manufacturing (AM)	Terrapin Works tour	First 3D Print OUT (Lynda.com lectures to watch)
2	Feb 5	Materials used in 3D Printing and their Pitfalls: Introduction to (Additive) Prosthetics Manufacturing	3D printing work	
3	Feb 12	Overview of amputation levels and causes, basics of transtibial (below knee) prosthetic design, mobility classifications	Guest lecture: Eli Fastow - Introduction to scanning technology (Artec & Geomagic Capture)	
4	Feb 19	Basic foot anatomy, Normal gait, Integration into prosthetic foot design	Prosthetic foot lab (getting to know the current foot market)	
5	Feb 26	Design considerations and testing for prosthetic feet	Prosthetic foot testing and data collection	Midterm project posted
6	Mar 5	Designing for the individual: case assignments	Preliminary design lab – ask a patient, initial sketching and CAD	
7	Mar 12	Guest Lecture: Dr. Ryan Sochol – Multimaterial additive mfg prosthetic application	Project work	
8	Mar 19	*No Class - Spring Break*		
9	Mar 26	The greater good: Groups that exist to promote and facilitate advancement in 3D printed prosthetic devices (Project E-Nable)	Project work	

10	Apr 2	Guest Lecture: Ethan Reggia - When to use Additive Manufacturing	Testing and data collection of Prototype 1	Midterm project due
11	Apr 9	Guest Lecture: Dr. Axel Krieger - Medical Robotics	Project work – refining	
12	Apr 16	Prosthetic Socket Design: Improving efficiency with 3D printing.	Project work – refining	
13	Apr 23	The global perspective: User needs in the developing world versus the developed world (3D PrintAbility, Nia Technolgies, ROMP)	Testing and data collection of Prototype 2	
14	Apr 30	Future direction of prosthetic trends in research towards higher end devices	Final refinements, final project work	
15	May 7	Final project deliverable presented	Final project deliverable cont.	Final project due

3D Printed Projects

Students are encouraged to visit Terrapin Works for help and production of their designs.

P1: First practice print, household object

P2: Midterm project, initial prototype

P3: Final project, revised prototype