**BME460L: Design of Medical and Assistive Devices**

**Instructor**

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**Lecture & Lab**

Lecture: Monday and Wednesdays, 3:30-4:45, Design POD

Lab: Monday and Wednesdays, 4:45-6 hours, Design POD

Lab time is allocated as protected project time for your team to utilize to collectively and to meet with clinical or technical advisors. Outside of these times, the labs should be available to your team with the exception of scheduled class times. These design spaces are expected to be heavily utilized so planning will be important. **It is expected that you will have to spend considerable time outside of set class hours to complete your project.**

**Course Overview & Outcomes**

Design of custom devices to aid individuals with disabilities. The goal of the class is to develop and design a device, system, material, or process, subject to real-world constraints such as time, money, and resources, that addresses the need you identified drawn from Duke hospital/medical personnel, local companies and organizations around Duke University. Formal engineering design principles will be emphasized; overview of assistive technologies, patent issues, engineering ethics. Oral and written reports will be required. Selected projects may be continued as independent study.

Student teams will successfully develop a prototype to solve a client-based design challenge through following engineering design steps:

**Upon completion of the course, students should be able to:**

* Describe/define client’s need/space
* Report/Investigate current designs/challenges and solutions
* Generate design criteria and evaluate design against these criteria
* Brainstorm solutions for your client
* Evaluate and prioritize ideas via matrix selection
* Prototype and build physical solution
* Work iteratively to evaluate and improve the solution
* Develop and implement safety and functional testing plans
* Work collaboratively on an engineering team to complete design project
* Work collaboratively on an engineering team to write technical documents and present oral/visual technical reports
* Work safely in space allotted

**Prerequisites**

* BME354 or permission of the instructor

**Course Objectives**

1. Design and construct a device to meet the need of a person with a disability.
2. Perform a quantitative analysis of the design.
3. Apply appropriate statistical methods during the design process.
4. Work as a team (e.g. with other students, the client, the client’s therapist, teachers, etc) to devise a safe and effective solution.
5. Prepare an oral presentation to clearly describe the work performed and outcomes.
6. Prepare a written report describing the project and outcomes, including professional-quality technical drawings and user’s manual.
7. Research and discuss an ethical issue in biomedical engineering.

**Student outcomes addressed by the course**

| **Student Outcomes and Program Criteria** | **I** | **II** | **III** | **IV** | **V** | **VI** | **VII** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| (a) apply knowledge of math, science, and engineering | x |  | x |  |  |  |  |
| (b) design/conduct experiments, analyze/interpret data |  | X |  |  |  |  |  |
| (c) design system/component/process with realistic constraints | X |  |  |  |  |  |  |
| (d) function on multidisciplinary teams |  |  |  | X |  | X |  |
| (e) identify/formulate/solve engineering problems |  | x |  |  |  |  |  |
| (f) understand professional and ethical responsibility |  |  |  |  |  |  | x |
| (g) communicate effectively |  |  |  | x | x | x | x |
| (h) understand the impact of engineering solutions | x |  |  |  |  |  | x |
| (k) use techniques/skills/modern engineering tools | x |  |  |  |  | x |  |
| (2) apply math/science/egr to interface of egr and biology | x |  |  |  |  |  |  |
| (3) apply statistics to interface of egr and biology |  |  | X |  |  |  |  |

x ‒ course addresses the Outcome/Criterion

**X** ‒course addresses the Outcome/Criterion and collects assessment data

In order to accomplish this in a semester, you will need to work consistently which will require project planning.

**Attendance and Participation**

Attendance and participation is important because you will be working in groups the entire semester. Participation in in-class activities and in out-of-class team activities will count for 20% of your class grade.

It is very understandable that students will have to miss class for job interviews, personal reasons, illness, etc. Absences will be considered excused if they are communicated to instructor at least 48 hours in advance (subject to instructor discretion as an excused absence) or, for illness, through submission of a Short Term Illness Form (STIF) before class. Unexcused absences will count against the participation component of your class grade.

**Textbooks & Resources**

There are no required textbooks for this class. The following texts are available on hold and are great references for the design process we will be engaging in this semester:

* Engineering by Design (Voland)
* Engineering Design: A project-based introduction (Dym, Little, Orwin)
* Design of Biomedical Devices and Systems (King, Fries, Johnson)
* Biodesign: The process of innovating medical technologies
* Product Design and Development (Ulrich, Eppinger)
* A variety of online resources will be referenced throughout the semester.

**Grading**

The course Sakai site will be used host any assignments. Due dates--including those that change--will be announced via email and be posted to Sakai. The following grading scheme is subject to change as the semester progresses:

Group

* Device development and prototyping exercises (3 formal assessments) - 10%
* Final Report and Documents - 15%
* Detailed Device Evaluation – 10%
* Final Project - 20%
* Project presentation(s) - 5%

Individual

* Individual Writing -10%
* Peer and Faculty Evaluation, Quizzes, Reflection and Prep Assignments - 20%
* Team Contribution and Lab Notebook Scores – 10%

**Class Schedule**

The course schedule is very likely to change depending on progress and Covid status throughout the semester. The updated schedule will always be available on Lessons on Sakai.

**Brief list of topics to be covered**

* Interacting with people with disabilities: To prepare students for their first client meetings, health care professionals and people with disabilities, we will have a relating to disability issues. The session includes a discussion of People First language.
* Engineering Design. Example designs introduce students to the engineering design process, providing a framework for their design experience.
* Engineering Communications. Students receive instruction on writing concise technical reports and developing clear oral presentations. Instructors provide extensive feedback to the students on all written assignments and oral presentations, and students help edit each other’s writing.
* Product Safety. This presentation includes an overview of the engineer’s role in safety, how standards apply, and a method for risk assessment that students apply to their projects.
* Ergonomics and Universal Design. These topics are presented along with a discussion of student-created examples from campus. Students incorporate these principles into their designs.
* Engineering Ethics. Students research a topic in ethics in engineering or medicine, and present their topic to the class, answering relevant questions.
* Guest Lectures. Guest lectures may include: Materials, Fasteners, Engineering Sketching, Industrial Design, Patent Issues, and others.

**Duke Community Standard & Academic Honor**

Engineering is inherently a collaborative field, and in this class, you are encouraged to work collaboratively on your projects. The work that you submit must be the product of your and your group's effort and understanding. All resources developed by another person or company, and used in your project, must be properly recognized.

All students are expected to adhere to all principles of the Duke Community Standard. Violations of the Duke Community Standard will be referred immediately to the Office of Student Conduct. Please do not hesitate to talk with your instructors about any situations involving academic honor, especially if it is ambiguous what should be done.

Students with disabilities who believe they may need accommodations in this class are encouraged to contact the Student Disability Access Office at (919) 668–1267 and speak with an instructor as soon as possible to better ensure that such accommodations can be implemented in a timely fashion.