BIOMEDE 350: INTRODUCTION TO BIOMEDICAL ENGINEERING DESIGN
WINTER 2018

Bulletin Description: This course uses problem-based learning to introduce students to biomedical engineering design concepts, tools, and methodologies. Students will work in groups and use virtual design and computational tools to propose and validate feasible solutions to real-world biomedical engineering problems with industrial and/or clinical relevance.

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Time & Location:

All software tutorials: GGBL 2517; Mon & Wed, 9-10:30 am
Other lectures & Reviews: FXB 1012; Mon & Wed, 11:30am-1:00 pm

Office Hours: For software tutorials, office hours are in the "*No formal lecture: Work on SolidWorks-based assignment on your own*" sessions.

For design projects: multiple meetings with the technical advisors will be arranged.

Credits: 3

Course Description:
This course, intended for 3rd-year undergraduates majoring in biomedical engineering, will expose students to key aspects of the process of designing a biomedical device or biotechnology product, and provide them with the technical fundamentals to perform design.

The primary focus of this class will be the solution of design projects intended to provide students with practical experience through "virtual" solutions of biomedical engineering problems and design of biomedical devices and technologies (**paper design**). Students will pose feasible solutions to real-world biomedical problems and perform engineering analyses to substantiate their proposed solutions. Design projects will be **open-ended problems** with no single correct answer, but more constrained than typical design problems to reflect the more introductory nature of this course.

The course will rely more on active, experiential learning than on traditional didactic lectures and passive learning. Lecture time will be designed to impart some general knowledge of problem solving and design, present the engineering and physiology background relevant for design projects and assignments, and provide tutorials for relevant software packages commonly used in biomedical engineering. Students will also have dedicated time during the lecture periods to actively use the relevant software packages. Through the assignments and the design projects, students will gain familiarity with three different software packages: **Matlab**, **COMSOL**, and **SolidWorks**. Mastery of these packages will only be attained through extensive self-study, and therefore ample time is allocated for independent study.

Design Projects:
Students will work in small groups on constrained design problems related to medical products. Projects will require the use of SolidWorks and COMSOL (and Matlab if needed) for virtual design and simulation. Further details will be provided on the content of your assignments and these design projects (i.e., what you have to hand in and when) as we move along.

Required Textbooks: There are no required textbooks. Some lecture content will be based on materials in ***Biodesign: The Process of Innovating Medical Technologies*** by Yock, Zenios, and Makower (Cambridge University Press, 2009).

Prerequisites: BIOMEDE 211 (Circuits and Systems for BME),
BIOMEDE 221 (Biophysical Chemistry and Thermodynamics)
BIOMEDE 231 (Intro to Biomechanics)
Corequisites: BIOMEDE 241 (Biomedical Engineering Undergraduate Lab)

Software Requirements: The three major software packages that we will use in this course are *Matlab, COMSOL, and SolidWorks.*

Matlab is a mathematics package that provides a high-level programming language, an interactive computing environment, and functions for algorithm development, data analysis/visualization and numeric computation. http://www.mathworks.com/

COMSOL is a modeling package for the simulation of any physical process you can describe with partial differential equations (PDEs). It features state-of-the-art solvers that address complex problems quickly and accurately, while its intuitive structure is designed to provide ease of use and flexibility. http://www.comsol.com/

SolidWorks is a computer-aided design software package widely used in engineering in general, and biomedical industry in particular. http://www.solidworks.com/

If you have no experience or familiarity with these software packages, do not fear – the point of this class is to teach you how to use them and give you the opportunity to practice. All 3 packages are available on CAEN Windows-based computers.

Lecture Topics (a more detailed schedule will be provided):

1. Course overview and introduction to design
2. Need screening and problem definition
3. Overview of design projects
4. Medical Imaging
5. Stakeholder analysis and regulatory basis
6. Matlab tutorial (1 section)
7. Finite element modeling
8. COMSOL module (3 sections)
9. SolidWorks module (3 sections)
10. Fusion 360 (1 section)
11. Entrepreneurship

Course Outcomes:

Upon completion of this course, students should be able to:

1. Define and solve design-oriented problems to gain familiarity with state-of-the-art software packages that are commonly used in engineering design.
2. Formulate feasible design strategies based on model algorithms.
3. Document the problem identification and algorithmic design.
4. Translate algorithms into computational tools.
5. Use computational tools for virtual design, including development, validation, and optimization of prototypes.

Grading Criteria:

Eight assignments	**49%**
Assignment 1 (Problem definition)	4%
Assignment 2 (Stakeholder & regulatory)	4%
Assignment 3 (Matlab)	7%
Assignment 4 (Comsol 1)	8%
Assignment 5 (Comsol 2)	8%
Assignment 6 (Solidworks 1)	6%
Assignment 7 (Solidworks 2)	6%
Assignment 8 (Solidworks 3)	6%
Design project	**38%**
Preliminary Design Presentation	10%
Final Design Presentation	13%
Written report for final design	15%
Written Report	
CAD	
Comsol	
Peer evaluation	**10%**
Class attendance	**3%**

Academic Honesty and the Honor Code:

The University of Michigan's College of Engineering Honor Code binds students enrolled in this course. For more details, please log onto the following URL: http://honorcode.engin.umich.edu/