BIOMEDE 350: INTRODUCTION TO BIOMEDICAL ENGINEERING DESIGN (4CR)
WINTER 2025 S001

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.

Contact Information

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Time & Location: Mondays & Wednesdays 2:30PM – 4:30PM, 1620 BBB

Office Hours: For software assignments, assistance will be provided during scheduled work times during class (see course schedule). Additional office hours will be arranged based on need. General Office Hours with Instructors TBD.

Prerequisites: ENGR 100 and (MATH 216 or 256 or 286) and MATH 215 and BIOMEDE 231 and BIOMEDE 241

Efforts toward an inclusive classroom:

1) We strive to create a culture of transparency, empathy, and flexibility by using intentionally designed and clearly communicated classroom norms. These norms can be adapted to changing student needs and can include accommodations to ensure equitable learning. If you would like to discuss any Accommodations, please reach out to the instructional team.

2) The teaching team is committed to creating an environment in which students can learn and grow as engineers and, more broadly, as people. To do this learning and growing together, we begin from a baseline of mutual respect and dignity in the community comprised of you, your peers, and the teaching team. If it is ever the case that this foundation seems jeopardized, we encourage you to reach out and discuss your concerns with a member of the teaching team; alternatively, you can also fill out this anonymous form (links to Google Form). **Please note** that if you choose to leave your name and indicate any possible instances of sexual or gender-based misconduct, that faculty are Individuals with Reporting Obligations (IRO). This involves filing with Equity, Civil Rights, and Title IX Office, where an adviser will contact you directly (link downloads a pdf) to determine a course of action, which can include remaining anonymous or seeking legal action.

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 physiological 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: **SolidWorks, COMSOL**, and **MATLAB**. 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, 2015). The U-M Library offers **free online access** to this book.

Software Requirements:
We will use three major software packages in this course: *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/

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

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 computers and the CAEN Remote Desktop Service.

Computational Resources and GenAI Policy

While CAEN computers (such as the ones in our classroom) are available around campus, some students elect to work from their own computers using the CAEN Remote Desktop Service,. If your personal computer becomes damaged and you rely on it for an assignment (or if you don't have one and need one), we highly recommend renting a computer immediately to avoid delays due to repairs from further blocking you from working on your coursework. Please reach out to the teaching team if you need assistance. There are two options that we know about for renting computers (for free):

North Campus Technology Checkout

From their website: "The North Campus Technology Checkout will offer a variety of technology tools and equipment for loan through a new, streamlined checkout system." This includes computers, among other things.

BME-IT Department

Our department has a limited number of loaner computers available for students to use. Please email bme-it@umich.edu to ask for loaner computer availability.

Information and Technology Services

The future is upon us, and so we adapt. The University of Michigan's Information and Technology Services has developed their own AI Services and AI platform, offering several options for generating content and providing datasets. I HIGHLY recommend reading the ITS AI Services FAQ for more information about how these services work, what happens to the data you input to them, how reliable the data they output is, and the most recent "best practices". I recommend this so much that if you email me what your favorite FAQ is and tell me why it's your favorite, then you will accumulate two extra credit points towards the maximum allowed.

Generative AI (GenAI), Large Language Models (LLM), and Other Machine-Generated Content

You are, at a minimum, expected to produce the first attempt of all written assignments without machine generated assistance. However, you are permitted to use GenAI (e.g. ChatGPT, U-M GPT, or other LLMs) to assist your work after your initial effort. If you or your team choose to apply such tools to assist with assignments or other course work, then your **use must be fully disclosed and adequately described at the time the work is submitted or reviewed**.

In this course, full disclosure and adequate description include two components:

1. You must indicate, with an in-text citation, each section for which the tool was used, even if you have rephrased the generated information.
    a. **Note** that this is in addition to standard citation practices for information that is not "common knowledge", which is most knowledge you will be writing about. See the Citation Help Research Guide from the U-M Library for more information on citation methods; ask for help if you are unsure.
2. You must include a reference, within your bibliography, with the following information:
    a. which GenAI tool used, including relevant version numbers
    b. the exact prompts that were used
    c. the date you used or accessed this tool
    d. the results you received
    e. a description of how the information provided by the tool was confirmed by your team to accurately reflect your intentions, and/or how the content was revised during this confirmation process
    f. **NOTE:** Depending on the length of this description, you may wish to create an appendix, rather than placing it in your bibliography. If the assignment would otherwise not include a bibliography, then the information should be appended to the end of the assignment (ie. an appendix) instead.

Failure to acknowledge the use of GenAI and similar tools may be considered a violation of the CoE Honor Code and may lead to a finding of academic misconduct (see Academic Integrity for more information). The use of such tools in this course does not endorse their use in other courses or in other environments. In general, students should be very careful and transparent when using machine-enabled technologies to enhance their work.

Course Management
All course content will be coordinated through the Canvas site, please reach out if you do not have access.

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

1. Apply the Design Process to future problems
2. Translate real life items and ideas into 2D and 3D models accurately
3. Apply computational tools to test 3D models with physical phenomena
4. Effectively work on a project team while using inclusive practices
5. Understand the big picture of design in the engineering field

Grading Criteria:

Assignment Types, names, and percentage of overall course grade	
In-Class activities = 2%	
Teamwork Reflection & CATME	0.5% (0.25% each)
Team Contract	0.5%
Reference Hunt	0.5%
Sketches	0.5%
Design Assignments = 12%	
User Needs & Problem Definition	4%
Design Inputs: Requirements & Specifications	4%
Validation & Verification Plan	4%
Computational Assignments = 36%	
MATLAB	3%
Solidworks 1	5%
Solidworks 2	5%
Solidworks 3	5%
COMSOL 1	6%
COMSOL 2	6%
COMSOL 3	6%
Design Deliverables = 40%	
Preliminary Design Review (PDR)	10%
Final Design Review (FDR)	15%
Final Design History File (Report)	15%
Peer Evaluation = 10%	
PDR Peer Eval	5%
FDR Peer Eval	5%

Descriptions of Assignment types

In-Class activities will be performed during class time and will directly relate to the lecture content for that day. Often, they will be useful “first steps” for other major assignments and may be individual or group assignments. In-Class assignments will be due “by the end of class” as they are expected to be completed during class. The Canvas deadline is 2 calendar days later to allow for any possible technical or personal difficulties to be resolved.

Design Assignments are group assignments related to your semester long design project. Each design assignment is a draft of a section of the final report and will likely prove useful for presentations. See Design Deliverables for more information.

Computational Assignments are either tutorials or complementary with tutorials for the software we cover in the course. These are individual assignments.

Design Deliverables are functionally two presentations and a final report related to your semester long design project. Design Reviews and the Design History File (DHF) carry greater meaning within Industry, but for the purposes of this class we are calling the presentations "Design Reviews" and the final report the "DHF".

Peer Evaluations are collected through CATME after the preliminary and final design reviews. Each is worth 5% of your grade (equivalent to a homework assignment). Grades are based on two aspects: unique comments provided for all team members and the scores calculated by CATME based on team member input. In extreme cases, evaluation scores may be used to adjust the scores of the preliminary and final design reviews after investigation and discussion between the teaching team and student team members involved.

Letter grades will be assigned as per this straight scale of percentages:

A+ ≥ 100 A ≥ 93 A- ≥ 90 B+ ≥ 87 B ≥ 83 B- ≥ 80 C+ ≥ 77 C ≥ 73 C- ≥ 70 D ≥ 60 F < 60

The instructional team reserves the right to adjust this scale as we feel is needed (only to improve the class' grades, never to lower them). Within Canvas, the points associated with each assignment will sum to 1000, and your overall class percentage can be determined by dividing your overall points by 100. For example: an in-class assignment (0.5%) is worth 5pts in canvas. If you have 918 points accumulated, your final grade is 91.8% = A-. There is up to 1% of extra credit allowed per student, though there may be more than 1% possible to obtain during the semester.

Policies and Statements

Communication

For questions relating to general course material or assignments, please post on Piazza – you will achieve the fastest answer in this manner, and your classmates will benefit as well. We may ask that questions sent over email be posted first on Piazza before a response is given such that the whole class can benefit. Exceptions to this policy include questions pertaining to the design projects and matters that are private or individual, relating to course progress, advising, any difficulties or challenges, etc.; these should be communicated individually with the instructors through email either using personal emails or the class email, VMO.management@umich.edu. At later stages of the course, you may be assigned an "Engineering manager" specific to your project type whom you should email directly. This will be announced in class and on Canvas.

Canvas announcements will be used to broadcast major changes to deadlines, classroom location/modalities, and grading policy. While the Canvas announcements will likely be reiterated in class, consider the announcements to be the most official communication. Watch for new announcements frequently!

Deadlines and Regrades

Deadlines for all deliverables are available in the Course Schedule available on Canvas. To account for technical difficulties, there is a 15-minute grace period for late assignment submissions, after which a 20% deduction per day late will be in effect.

If you have a foreseeable conflict with a deadline, or a deadline conflicts with a religious observance (please see university policy here), please reach out to the instructors at least two weeks in advance for alternate arrangements.

Emergency matters will be handled on an individual basis, please contact the instructional team as soon as it is safe to do so. Questions about grading or requests for a re-grade are permitted but must be submitted no more than one week after the release of grades.

(Syllabus continues on next page)

Academic Integrity
Students in this course are bound by the College of Engineering Honor Code. Details of the Honor Code can be found here, and specific applications to assignments in this course are listed below. Any suspected violations of the Honor Code will be sent to the Honor Council.

- **For individual (software) assignments**: You may discuss approaches, concepts, and strategies with other students, but the code, inputs, and outputs must be your own work.
- **For group assignments**: These are to be done collaboratively within your group, receiving help or advice only from the instructional team as needed.
- **If assistance from GenAI is used,** its use must be disclosed and adequately described**,** as outlined earlier in this document. If you are not certain your use and disclosure is adequate, please reach out to the instructional team with ample time before the assignment due date.

Mental Health and Well-Being
Maintaining your health is of paramount importance, and we encourage any student who is struggling to seek support with these matters rather than trying to navigate them alone. You are NOT alone, and do not by any means deserve to struggle. Additionally, if you are struggling with currents events or individual hardship, please consider reaching out. We can help connect you with relevant resources, such as the C.A.R.E. Center or Counseling and Psychological Servies (CAPS). You may be able to receive immediate help or find more long-term help with classroom accommodations. Beyond what is here, UofM's Well Being Collective has even more tools and resources that may be helpful.

Accommodations for Students with Disabilities
The University of Michigan recognizes disability as an integral part of diversity and is committed to creating an inclusive and equitable educational environment for students with disabilities. Students who are experiencing a disability-related barrier should contact Services for Students with Disabilities https://ssd.umich.edu/; 734-763-3000 or ssdoffice@umich.edu). For students who are connected with SSD, accommodation requests can be made in Accommodate. If you have any questions or concerns please contact your SSD Coordinator or visit SSD's Current Student webpage. SSD considers aspects of the course design, course learning objects and the individual academic and course barriers experienced by the student. Further conversation with SSD, instructors, and the student may be warranted to ensure an accessible course experience.

Religious Observances
The University of Michigan, as an institution, does not observe religious holidays. However, every reasonable effort will be made to help students avoid negative academic consequences when their religious obligations conflict with academic requirements. If you find that a presentation or assignment due date conflicts with a religious observance, it is your obligation to let the instructors know at least 2 weeks in advance of the conflict. You will be given every opportunity to make up the work without penalty unless it interferes unreasonably with course delivery. Read the University's full policy here: https://provost.umich.edu/resources-policies/calendars/

Flexibility
All statements and policies in this syllabus and otherwise present (e.g. on the course Canvas) are subject to change; such changes will be communicated class-wide through Canvas announcements and updated documentation will be made available as needed. If you feel that a particular course policy on this syllabus is harmful or obstructive, please feel free to email the teaching team OR use the anonymous form described on the first page of the syllabus. Generally speaking, suggestions and comments are welcome.