



BME 498Y: Biomedical Engineering Capstone Design

1. Calendar Information

In this project-based design course teams of students from diverse engineering disciplines (enrolled in the biomedical engineering minor) will engage in the bio-medical technology design process to identify, invent and implement a solution to an unmet clinical need. The students will learn about medical technology development and will engage in the process through lectures, guest lectures delivered by medical technology experts, "hands-on" practicums and a student driven design project. Approval to register in the course must be obtained from the Associate Chair, IBBME - Undergraduate. Course Description Reference:

https://portal.engineering.utoronto.ca/sites/calendars/current/Course_Descriptions.html

2. Course Overview

BME498 is a capstone design project course intended to have students identify unmet clinical needs and/or healthcare-related problems and define a design challenge. In the course of proposing an innovative solution, students are expected to apply their technical background to address the design challenge. Students will be expected to perform additional self-study to understand their challenge but course expectations will be supported by “hands-on” activities presented in lecture and laboratory periods to orientate each team toward proper engineering design. The student-driven design project will take place over both semesters as each team proposes a project and develops a design from initial concept to final working prototype.

The goal of this course is to provide students with the opportunity to practice innovation and engineering design skills within a biomedical context and increase awareness of future entrepreneurial activities. Topics will include needs finding, needs screening, product design specifications, concept generation, concept screening, prototyping, risk assessment, and quality control of medical devices.

3. Learning Outcomes and Graduate Attributes

At the end of this course, you will be able to:

1. Identify user/stakeholder needs through a user-centered approach
2. Describe a credible and professionally acceptable approach to “engineering design”
3. Summarize and justify design choices in oral and written formats
4. Incorporate realistic constraints of medical technology development into engineering design
5. Plan and manage engineering activities to within time and budget constraints
6. Document an engineering design in a form suitable for clients to continue project
7. Develop a functioning engineering prototype of a product or service



4. Timetable

Section	Day of the Week	Start Time	Duration (Minutes)	Location
Lec	Thursday	09:00	120	MY 320
Pra	Thursday	13:00	180	MB 78/64

Office Hours: <https://calendly.com/chris-bouwmeester/fall2018-office-hours>

5. Course Instructors

Course Coordinators

Name	Phone	Office	Email
Chris Bouwmeester	(416) 978-3702	MB321A	chris.bouwmeester@utoronto.ca

Prof. Bouwmeester is be the main point of contact for students and is responsible for evaluating and providing feedback to students.

Teaching Assistants

Name	Phone	Office	Email
Arushri Swarup			arushri.swarup@mail.utoronto.ca
Philippa Gosine			p.gosine@mail.utoronto.ca

Ms. Swarup will be available during your practicum time in the design studio to help you with technical aspects of your design projects. In her role as project supervisor she will assist individual teams and be the first person that students should turn to for help. In this way they are a bridge between the course instructor and the individual teams. As such, they will attend all of your team meetings to monitor how well individuals are functioning as part of a team and provide evaluations of your team engagement as well as written and oral deliverables.

Communication Instructor

Name	Phone	Office	Email
Nikita Dawe			nikita.dawe@mail.utoronto.ca

Ms. Dawe will provide support and feedback regarding your written and oral communications. She will provide feedback on your engineering communication specifically for the project proposal to enable your improvement for the final report. She will also give you feedback on a practice oral presentation before your final presentation to clients and your fellow students.



6. Final Grade Determination

The final grade in this course will be based on the following components:

Component	Learning Outcome(s) Evaluated	Due Date	Weight
Individual			
Pre/Post-Class Assignments & Progress Documentation	2, 3, 4, 6	See Schedule	10 %
Progress Presentations	3, 5, 6, 7	See Schedule	10 %
Team			
Project Requirements	1 – 4	Oct 11	15 %
Project Proposal	1 – 6	Nov 15	10 %
Design Review and Critique	3	Jan 17	15 %
Demonstration Day	3	Mar 28	15 %
Final Report	1 – 7	Apr 4	25 %
Total:			100 %

7. Deliverables

All written submissions must be received by 11:59 PM on the date listed. Additional details related to each deliverable are given in guideline documents posted in the Assignments Submission section in Quercus.

Pre/Post-Class Assignments & Progress Documentation

The goal of pre/post-class assignments is to come to class prepared to work on an important component of your project. Each assignment is linked to an key component of the reports and presentation. The aim is to do individual work that can be combined with your teammates to prepare for your project deliverables and get feedback on how to do these activities proficiently during class.

Pre-class assignments must be submitted (in Quercus) before the class, in which they are associated with, begins. Pre-class assignment review material and instructions will be presented in the lecture and posted on Quercus before these assignments are due. You must keep up to date regularly of any scheduling changes during the semester. As table 1 below shows, grades will be given for: 1) completion and delivery of the assignment and 2) participation during class. For example, full marks (i.e., 3/3) would be given for an assignment handed in on time and participation during class. In this course, active participation is defined by asking questions



and/or participating in activities either with your group or individually. Passive participation, which means simply showing up for class, is not enough to be considered active participation. If you cannot attend the lecture associated with the pre-class assignment, please see the attendance policy in section 11.

Mark	Completion and Delivery Criteria
2	<ul style="list-style-type: none"> • Assignment submitted before class • Complete answers
1	<ul style="list-style-type: none"> • Assignment submitted late but before the end of class • Incomplete answers
0	<ul style="list-style-type: none"> • Assignment handed in late

Mark	Participation Criteria
1	<ul style="list-style-type: none"> • Active participation
0	<ul style="list-style-type: none"> • Absent from class

Table 1: Pre/Post Class Assignment Rubric

Meeting regularly is vitally important to make decisions as a team and document the progress your team makes throughout this course. Each team is responsible for setting up meetings with experts and users outside of the classroom and be responsible for conducting and documenting team meetings. The minimum expectation is that every outside and team meeting (scheduled during practicums noted in the schedule) is recorded. After each scheduled team meeting you must submit your complete collection of meeting documentation to that date – i.e., your final submission should be a collection of a meeting documentation that occurred during the whole semester. You have the freedom to choose your format or platform for meeting documentation but it must be submitted electronically. Best practice is to distribute an agenda prior to a meeting and record all feedback and agreements made during meetings. Please refer to ‘*Guidelines for Meeting Documentation*’ (posted on Quercus) for more information on professional meeting documentation.

Mark	Completion and Delivery Criteria
3	<ul style="list-style-type: none"> • Complete collection of documentation
2	<ul style="list-style-type: none"> • Minutes recorded
1	<ul style="list-style-type: none"> • Minutes are unclear
0	<ul style="list-style-type: none"> • Not submitted for review

Table 2: Progress Documentation Rubric

Progress Presentations

Your attendance is mandatory for all progress report dates and absences may result in less than full marks. Each individual must present a 3-minute update to show their progress followed by questions posed by the teaching team. Every member of each team must present at least once and if there is a team of 4, one person must present twice. As an individual presenter, your goal is to present your progress clearly and succinctly (if there was no progress, the presenter will discuss the technical hurdles encountered and the plan to overcome them). For the team, the goal is to



monitor progress and to detect problems early and to get feedback from the teaching team and the other student teams. Each individual will receive full marks for presenting a progress report for their team and attending all other progress reports that they do not present personally.

Project Requirements

Gathering information about your chosen problem and building an accurate understanding of your healthcare-related need will allow you define what a design *must do* to be an acceptable solution. Furthermore, you must also be able to find ways to differentiate different designs you create and define what a design *should be* and/or *must be* in order to be successful. Your team is responsible for submitting a concise document that communicates the design requirements (specifications) of your stated need. Please refer to '*Guidelines for Project Requirements*' (posted on Quercus) for more information.

Project Proposal

Your team is responsible for drafting a project proposal document that: 1) defines the design problem, 2) proposes possible solutions and selects the most promising design, and 3) provides a plan to carry out the proposed solution. Please refer to '*Guidelines for Project Proposal*' (posted on Quercus) for more information.

Design Review and Critique

Each team will present an overview of their project and show preliminary prototypes created so far. The aim of this presentation is to demonstrate your knowledge of a healthcare need and the problem you have chosen to solve. The team will defend their design and key decisions with the aim to set your team up for building a working prototype during the winter term.

Demonstration Day Presentation

Each team will present their design and demonstrate their final working prototype to the project supervisors and hopefully some of the users you have connected with as well. Consider this presentation as a pitch to investors or a presentation at a design competition where you still need to clearly communicate the need you are addressing and the problem you are offering a solution to. The Focus of this presentation should be proving, with test results, that your design solves the problem you have identified. The most successful teams will be able to demonstrate how their design works and this is best achieved by performing a live demonstration. Please refer to '*Guidelines for Demonstration Day Presentation*' (posted on Quercus) for more information.

Final Project Report

Your team must produce a final report that summarizes and documents your work and final results. While much of the project proposal can be reused, you should incorporate feedback from your client, project supervisor, teaching assistants, and fellow students (if applicable) to demonstrate you have iterated your original goals, ideas, concepts, designs, etc. The major focus of this report is to: 1) provide further documentation of your technical aspects of your design, 2)



demonstrate how you have tested (e.g. performance) of module- or system-level designs, and 3) make recommendations for future development. Please refer to ‘*Guidelines for Final Report*’ (posted on Quercus) for more information.

8. Textbook

The required textbook for this course is: Biodesign by Yock. This textbook also has a large amount of online resources (<http://ebiodesign.org/>) helpful. You may also find other design textbooks listed below are helpful to you during the design process and in medical device development in general

Required:

Title	Biodesign – The Process of Innovating Medical Technologies
Author(s)	Yock, Zenios, Makower, Brinton, Kumar, Watkins, Denend
Edition, Year	2nd Edition (2015)
Publisher	Cambridge University Press

Suggested:

Title	The Mechanical Design Process
Author(s)	Ullman
Edition, Year	5th (2016)
Publisher	McGraw Hill

Title	Designing Engineers – An Introductory Text
Author(s)	McCahan, Anderson, Kortschot, Weiss, Woodhouse
Edition, Year	1 st (2015)
Publisher	Wiley

Title	Medical device design: innovation from concept to market
Author(s)	Peter J. Ogradnik
Edition, Year	First edition 2013
Publisher	Academic Press

Title	Class 1 devices: case studies in medical devices design
Author(s)	Peter J. Ogradnik
Edition, Year	2015
Publisher	Academic Press



9. Course Policies

Accommodations for Disabilities

Students with diverse learning styles and needs are welcome in this course. The University provides academic accommodations for students with disabilities in accordance with the terms of the Ontario Human Rights Code. This occurs through a collaborative process that acknowledges a collective obligation to develop an accessible learning environment that both meets the needs of students and preserves the essential academic requirements of the University's courses and programs. For more information on services and resources available to students, please contact Accessibility Services at (416) 978-8060 or <http://www.studentlife.utoronto.ca/as>. Should you have a Letter of Accommodation, you shall notify the instructor within the first 3 weeks of the term to allow appropriate accommodations to be integrated into the course.

Lateness Policy

Graded reports received later than the due date posted will be awarded a 10% deduction compounded for every day that the submission is late. Exceptions may be accommodated for valid reasons (such as severe illness or compassionate grounds), that are out of a student's control, and may be considered if supported by written documentation. Examples of invalid reasons would include situations where Quercus submissions were not executed properly by a student, or a student forgot the deadline.

Attendance Policy

While no notification of your absence is necessary, if you are absent, you will be responsible for gathering the information you need from your peers. In the case of the progress presentation that you must deliver, you should coordinate with you team to ensure you will be able to present. If you have a time conflict (e.g., religious obligation, varsity team involvement, academic conferences) with one of the lecture dates where your attendance is counted toward your participation grade you must notify the instructor beforehand to make possible alternative arrangements.

Online Communication Policy

All course-related questions should be posted in the "Course Q & A" discussion. If you have a question you should: 1) check the syllabus or guidelines for your answer, 2) check the Course Q & A discussion to see if your question has already been answered, or 3) ask a peer directly. Every attempt will be made to respond within 3 business days to posts that need the attention of the corresponding TA. If necessary, you may email the corresponding TA (or instructor, if absolutely necessary) regarding personal issues that may impact this course. BME498 must be used at the beginning of the subject line to ensure prompt response to emails. Every attempt will be made to responded to emails within 3 business days.



Academic Integrity Message

Plagiarism is taken very seriously and as per the code of behaviour on academic matters: “it is the students’ responsibility to know what constitutes an academic offense”. As per University of Toronto guidelines: “You need to integrate your acknowledgements into what you're saying. Give the reference as soon as you've mentioned the idea you're using, not just at the end of the paragraph. It's often a good idea to name the authors ("X says" and "Y argues against X,") and then indicate your own stand ("A more inclusive perspective, however, ... ")”. Specific instructions on bibliography formats will be given in assignment guideline documents but as a general rule; it is not acceptable to rely on Wikipedia or Google rather than library resources. For more information, please see (www.writing.utoronto.ca/advice/using-sources/how-not-to-plagiarize) for a practical guide and the following links for more information on University of Toronto policies: (<http://academicintegrity.utoronto.ca/>) (<http://www.governingcouncil.utoronto.ca/Assets/Governing+Council+Digital+Assets/Policies/PDF/ppjun011995.pdf>).

10. Additional Course Information

Pitch Night: Sept 11; 16:00 – 18:00, MY360

You are invited to listen to projects pitched to another capstone class that links clients with students in a fall semester capstone design course. You will not be selecting these projects but you may be inspired by the problems you hear.

Project budget

Up to \$500/team is provided to each team. An itemized budget will be included with the proposal and will need to be approved by the project supervisor before funds greater than \$100 are reimbursed. Additional funds (up to \$1000 total) may be approved if a strong justification is made to the course coordinator. Teams requesting extra funds will need to write a one-page grant application justifying the need for the additional funds

Design Studio

IBBME safety policy requires that all students take part in safety training prior to using the Design Studio. This has been scheduled for September 13. If students do NOT pass the safety test, they will be given one additional opportunity to rewrite and pass the test. The Design Studio introduction, safety presentation, and quiz should only take 30 minutes. A teaching assistant will be available every week during practicum time to answer questions or help you with your projects. The design studio will only be available during practicum time (i.e., Mondays from 9 – 12) but you may also be able to connect with the design studio facility at the Myhal Centre to work on your project outside of this time.



Teaching Lab

The IBBME Teaching Lab is also reserved for students in BME489 who need access to wet lab facilities. **There will be a mandatory training session for students who need access to the Teaching Lab.** To use this facility, you must contact the teaching lab coordinator at teachinglab.ibbme@utoronto.ca.

Awards

- John W. Senders (\$1,000)
“For imaginative and successful application of engineering to the design of a medical device capable in generality of its application to restore normal human function.” This award is decided by the Faculty-wide, Multidisciplinary Capstone Design committee.
- IBBME Director’s Biodesign Award (\$500)
“To the best BME489/BME498 project.” Decided by the IBBME Director.

Bonus Marks

You may choose to provide documentation that could be used as a submission to a relevant student design competition for bonus marks. A maximum of 2% bonus is available if you choose to do this extra work. Please see ‘*Guidelines for Bonus Marks*’ (posted on Quercus) for more information.