



BME 489F: Biomedical Systems Engineering

1. Calendar Information

A capstone design project that provides students in the Biomedical Systems Engineering option with an opportunity to integrate and apply their technical knowledge and communication skills to solve real-world biomedical engineering design challenges. Students will work in small teams on projects that evolve from clinical partners, biomedical/clinical research and teaching labs, and commercial partners. At the end of the course, students submit a final design report and a poster for public exhibition. Course Description Reference:

<http://www.ibbme.utoronto.ca/students/graduate/current/courses/descriptions/>

2. Course Overview

BME489 is a capstone design project course intended to give students an opportunity to apply their technical knowledge and communication skills to tackle complex, open-ended design problems in a realistic environment. These design problems are proposed by ‘client’ partners based in clinical and/or research labs. Working in teams of three to five, students develop a design project from an initial concept to a final working prototype. Each team will be assigned a project supervisor (i.e., one of the teaching assistants) who should be included in all communication with the project client. The proposal, presentation, and report will be evaluated by the project supervisor and the course coordinators. Each team is also responsible for initiating contact with their client and communicating with them throughout the course in a professional manner. At a minimum, each team should strive to communicate with their client by: 1) having an initial meeting, 2) presenting their proposal (if possible, in person), and 3) demonstrating how their final prototype functions (if possible, in person). Students are expected to have sufficient technical background that they can successfully address the design challenge with additional self-study. The goal is to assess the student’s capacity to practice innovation, entrepreneurial initiative, and engineering design within a biomedical context resulting in a functional prototype that meets a set of pre-defined technical specifications.

3. Learning Outcomes and Graduate Attributes

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

1. Describe a credible and professionally acceptable approach to “engineering design”
2. Summarize and justify design choices in oral and written formats
3. Apply previous knowledge and skills to open-ended design problems
4. Plan and manage engineering activities to within time and budget constraints
5. Develop a functioning engineering prototype of a product or service
6. Document an engineering design in a form suitable for intellectual property protection

Graduate Attribute Table



4. Timetable

| Section | Day of the Week | Start Time | Duration (Minutes) | Location |
|---------|-----------------|------------|--------------------|----------|
| Pra | Th | 09:00 | 180 | MB78 |
| Tut | Th | 14:00 | 60 | BA2185 |
| Lec | Th | 15:00 | 60 | BA2185 |

Office Hours: Mondays 13:00 – 14:00 in MB321A

5. Teaching Team

Instructors

| Name | Phone | Office | Email |
|-------------------|----------------|--------|-------------------------------|
| Chris Bouwmeester | (416) 978-3702 | MB321A | chris.bouwmeester@utoronto.ca |
| Jan Andrysek | (416) 978-1311 | MB329 | jan.andrysek@utoronto.ca |

Prof. Bouwmeester is be the main point of contact for students and is responsible for evaluating and providing feedback (focused on the design process) to students and will attend as many client, team meetings, and progress presentations as possible. Prof. Andrysek will act as an external reviewer and will also provide evaluations of the proposal, report, and presentation and will focus his evaluations and any feedback toward the product (i.e., prototype) produced by each team.

Innovation, Hammers & Nails Liaison Officer

| Name | Phone | Office | Email |
|----------------|------------------------------|----------------------|------------------------|
| Dr. Vito Forte | (416) 813-7654 Ext 201380 | 6278A Burton Wing | vito.forte@sickkids.ca |

Dr. Forte is the Innovation, Hammers & Nails liaison and his primary role is connecting clients at SickKids with your team. In this role he will attend as many SickKids client meetings as possible. He will also give feedback from a clinical perspective at the progress and final presentations.

Teaching Assistants – Project Supervisors

| Name | Phone | Office | Email |
|----------------|-------|--------|---------------------------------|
| Arushri Swarup | | | arushri.swarup@mail.utoronto.ca |
| Karly Franz | | | karly.franz@mail.utoronto.ca |

Ms. Swarup and Ms. Franz will be available to individual teams as they will be present in the design studio to help you with technical aspects of your design projects. In their role as project supervisor they will be linked with individual teams and be the first person that students should turn to for help. In this way they are a bridge between the course instructors 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.



Design Studio & Teaching Laboratory Coordinators

| Name | Phone | Office | Email |
|----------------|----------------|--------|-------------------------------|
| Max Giuliani | (416) 978-7188 | MB78 | design.ibbme@utoronto.ca |
| Lindsey Fiddes | (416) 978-1467 | MB325 | teachinglab.ibbme@utoronto.ca |

Dr. Giuliani is available to help you use the resources in the Design Studio and Prototyping Suite, which may include light fabrication or rapid prototyping. Dr. Fiddes is available to help you use the resources in the Teaching Lab, which may include wet lab facilities or microscopy.

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 |
|--|-------------------------------|----------------------------------|--------|
| Progress presentations (individual) | 1, 2, 6 | Sept 28, Oct 12, 26, Nov 9, & 23 | 5 % |
| Project proposal (team) | 1 – 7, 9 | Oct 5 | 25 % |
| Project presentations (team/individual) | 1, 2, 6 | TBD (Dec 4, 5, or 6) | 15 % |
| Project showcase (team) | 1, 2, 6 | TBD | 5 % |
| Project report (team) | 1 – 9 | Dec 6 | 40 % |
| Engagement (team) [Team meetings / Client feedback] | 1 – 9 | Dec 6 | 10 % |

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 submission section in Blackboard.



Peer Evaluations

The purpose of peer evaluations is to: 1) allow your project supervisor to understand how well your team is functioning after you submit your proposal, 2) promote positive team discussions that allows individual's to improve their performance, and 3) to allow, if necessary, grades for the report to be scaled appropriately to reflect individual effort. Both the proposal and report must include a peer evaluation that each individual will complete for all other team members. You must send your project supervisor your evaluation of your peers using the following evaluation matrix shown below. The peer evaluation component is worth 1% of your proposal or report grade and all team members must submit a peer review to receive full marks.

For the proposal, the peer evaluation will not be used to scale individual grades and instead will be used by your project supervisor to identify any issues that can hopefully be used as a basis for discussion amongst your team. For the report, the peer evaluations will be used to scale individual grades if the same issues identified via peer evaluation of the proposal have not been ameliorated. If the report peer evaluations display the same pattern as the proposal, then the peer evaluations will be incorporated directly but if the final report peer evaluations shown an unprecedented pattern, the instructor may only allow half of potential scaling to occur. Individual grades for the final report grade may be scaled up to a maximum of $\pm 10\%$ according to a scaling factor derived by dividing an individual's peer evaluation score by the average grade of all peer evaluation scores.

Peer Evaluation Matrix

| Indicator | Score of 1 Description | Score of 2 Description | Score of 3 Description | Score of 4 Description |
|----------------------------|--|--|---|--|
| Completion of tasks | Assigned tasks are not completed or not completed by deadline | Completes some tasks by deadline (or completes tasks only if repeatedly reminded) | Completes all assigned tasks by deadline | Completes work in advance with enough time to improve quality before deadline |
| Meetings | Often late and/or absent without notifying the team | Sometimes late and/or absent; may notify the team | Attends team meetings regularly and on time; consistently notifies team if late or absent | 3 + notifies team as far as possible if late or absent; follows up with team members to catch up on what they missed |
| Quality of Work | Work not usable by the team | Quality is inconsistent; may need to repeat some parts of the individual's efforts | Quality of work is satisfactory; only minor improvements required | 3 + proactively helps team members who produce work that requires improvements |
| Communication | Does not communicate or communicates with team members disrespectfully using ineffective tone, body language, and facial expressions | Communicates respectfully but does so inconsistently and/or to select team members | Communicates respectfully with all team members using effective tone, body language, and facial expressions | 3 + encourages other team members to communicate respectfully |

Progress Presentations: Sept 28, Oct 12 & 26, Nov 9 & 23

See the course schedule for the dates where each team will nominate an individual member to give a one-slide, 5-minute presentation on their progress to date. 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. Therefore, your attendance is mandatory for all progress report dates and absences may result in less than full marks.

Project Proposal: Oct 5

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 Blackboard) for more information. In addition to the electronic submission, you must also submit a hardcopy version of this document in the engineering communication program office drop box so that the communications instructor can provide feedback. You must also submit the proposal to your client (ensure that you cc your project supervisors) and, if possible set, up a meeting with them to communicate your proposal clearly and succinctly.

Project Report: Dec 6

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. You must also submit the report to your client (and cc your project supervisors).

Project Presentations: TBD (Dec 4, 5, or 6)

This is your major opportunity to demonstrate the progress you made to your client. The aim of these presentations is to demonstrate how your solution works to your client and describe the process you used to your project supervisors. Ideally your client will be present at the final presentations but if they are not available on the final date chosen, then each team is responsible for meeting with your client to demonstrate the functionality of your prototype so that they can provide the project supervisors with input regarding the potential of your design to meet the objectives you and they have agreed upon.

Project Showcase: TBD (During Exam Period)

The showcase is a joint poster session with the other fall semester Engineering Science capstone courses and is your opportunity to display your work to your wider Engineering Science community. Each team will create a poster and be judged on their communication of their design problem and the solution they created and tested to solve their client's problem.



Engagement: Dec 6

You are expected to engage with your client and project supervisor in a professional manner in all aspects of communication. Each team is responsible for setting up meetings with their client and informing their project supervisor (and Hammers & Nails client liaison, if necessary) when client meetings are scheduled. You will also be responsible for conducting and documenting (with agenda and minutes) 4 team meetings during tutorials (on Oct 5, 19, Nov 2, and 16) which will be attended by your project supervisor to monitor project progress and provide input if asked. In addition to a final submission of your meeting agendas and minutes, final feedback from your client (or their representative) and project supervisor will be incorporated into this grade component. Please refer to '*Guidelines for Project Engagement*' (posted on Blackboard) for more information.

8. Textbook

There are no formal textbooks for this course. However, you may find the Biodesign textbook and the 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.

| | |
|---------------|--|
| 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 |

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|---------------|-------------------------------|
| 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 |

9. Course Policies

Accommodations for Disabilities

Students with diverse learning styles and needs are welcome in this course. In particular, if you have a disability and/or health consideration that may require accommodations, please feel free to approach me and/or Accessibility Services at (416) 978-8060 (accessibility.utoronto.ca).



Lateness Policy

Graded assignments 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 Blackboard submissions were not executed properly by a student, or a student forgot the deadline.

Attendance Policy

While no notification of your absence is necessary for the course instructor, if you are absent, you will be responsible for gathering the information you need from your peers or communicating with your project supervisor or team members. In the case of the progress presentation that you must deliver, you should coordinate with your team to ensure you will be able to present. If you have a time conflict with one of the mandatory progress report dates that cannot be avoided (e.g., religious obligation) you must notify the instructor beforehand to make possible alternative arrangements.

Online Communication Policy

Every attempt will be made to respond to emails within 2 business days but will not be answered during weekends. BME489 must be used at the beginning of the subject line to ensure prompt response to emails.

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>).

Submission Policy

Submit written documents in pdf or Word format in Blackboard.



10. Additional Course Information

Project Pitch Night: Sept 12; 17:00 – 18:30

Project clients will present their projects during an interactive event where you are encouraged to ask questions to help your team choose your project. Potential clients will present their projects and answer questions. Brief project descriptions will be posted in advance to enable you to come prepared with questions for particular projects you are interested in selecting.

Project Selection / Client Matching

After the completion of the pitch night, each team will select their top 3 project preferences. A short 1 sentence description should be given with each choice that answers the question: “Why is your team the best match for this project?” Your answer should be: “Our team is suited to address this problem because ...” Every effort will be made to optimize the greatest number of teams matched with their highest preferences but to help the teaching team make a match your answers may be considered.

Project Supervisor

Each team will be assigned at least one teaching assistant to act as a project supervisor and they will be your first contact. You should keep your project supervisor informed about any issues with your team or project and you must copy them in communication with your client. During the scheduled team meeting times, you must arrange a block of time during the tutorial to meet (e.g., 2 – 2:20 PM) with them as per the ‘*Guidelines for Project Engagement*’ (posted on Blackboard).

Grading

Final grades of the project proposal and final report and presentation will be determined with a consensus of the course instructors and teaching assistants (i.e., project supervisors). Clients will only evaluate your project holistically as a part of the client engagement component of the final grade. If the client does not provide feedback for any reason, then the project supervisor will provide this component of the engagement on their behalf.

Tutorials

You are expected to attend mandatory tutorial sessions 1 – 3 that are designed to give you extra information that will help you succeed in producing a project proposal. Other tutorial sessions are designed as biweekly opportunities for team meetings and with your project supervisor.

Project budget

Up to \$750/team is provided by IBBME. An itemized budget will need to be approved by the course coordinators before beginning the project. Modifications to this budget will need to be approved by the client and the Teaching Team as additional funds (up to \$1,000) are available to individual teams. Interested teams will need to write a one-page grant application justifying the



need for the additional funds. Your client may be able to provide some resources but you will need to communicate with them directly.

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 14, in two blocks of time to accommodate all students. You must register in advance for either the 10:00 – 11:00 or 11:00 – 12:00 time slots. 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. Students are also welcome to use the Design Studio during “Open Bookable Time”; see <http://www.ibbme.utoronto.ca/facilities/design-studio/calendar/> for availability. Please use the online booking reservation form to ensure that the design studio is available.

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 Lindsey Fiddes in advance.

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 Blackboard) for more information.