Selected Topics in Biomedical Engineering
Course project for 2021

Overview

The course project involves producing a written report. Any professor who teaches in the course, or is associated with the BioMedical Engineering Department or the Bioengineering Department, can act as a supervisor for the project. In order to ensure that the project area is new to each student, the student must select a topic that is remote from their past and present research areas, with a supervisor who is not their research supervisor and is not working in the same area as their research supervisor.

Students will contact potential project supervisors. Professors are asked to supervise a maximum of two projects each. After the student and a supervisor have agreed on a topic, the course coordinator must approve the topic before the student begins to work on the project. Approval should be requested by e-mail with a cc to the potential project supervisor, and the request must include the following information: whether the student is undergraduate or graduate; the name of the supervisor(s) of any recent, current or expected research project, including both undergraduate and thesis research; and the topic(s) of such research.

Goal

The goals of this project span the three cognitive levels (‘knowing’, ‘understanding’ and ‘thinking’) and involve (i) learning about an area in biomedical engineering that is new to the student, and (ii and iii) explaining and synthesizing the area in the form of a written report.

Grading

The written report will be judged on the following aspects:
(1) accuracy and completeness of content (30%)
(2) organization (20%)
(3) clarity, synthesis, and insight (40%)
(4) quality of language and formatting (10%)

The synthesis and insight are the most challenging aspects, but also the most important ones. They reflect the ability to read, understand, and ‘digest’ large amounts of information and expose it clearly to readers who are not specialists in the area.

There will be a penalty of up to 10% if the length is outside the specified limits. There will be a penalty of 10% for each day or fraction of a day late.

Plagiarism will result in an F grade for the course in accordance with the Code of Student Conduct and Disciplinary Procedures.

Reports will be graded primarily by the project supervisor, with input from the course coordinator. Supervisors are asked to provide numerical grades. The course coordinator will apply any penalties for being late or for being too short or too long.

Deadlines

The project topic and supervisor must be selected and approved by 2020 October 7. The final written report must be received by 2020 December 7.

Projects types

Projects can be

- a review of one topic,
- an analysis and critique of one technique, or
- a comparison of two or three related techniques.

Report

The written report should be submitted as a formal term paper and should contain between 4500 and 5500 words including figure captions and tables but excluding title page, table of contents, abstract and references. Whether a table of contents or abstract is wanted is up to the project supervisor. Figures should be included within the text, not all put at the end. A serif font similar to Times New Roman should be used, with a size of 12 points. Page margins should be 2 to 2.5 cm all around.

The paper should begin by introducing the topic and describing why it is important. It should adequately cover the field, identify important papers, describe the significant elements of the problem, and discuss methods that have been developed to address these elements. The paper should finish with a discussion/conclusion and a list of references.

It is expected that students will meet with their project supervisor once or twice while working on their project, after the initial meeting in which the topic is agreed on. The project supervisor can give **general** support and thematic guidance but the report itself should be the student's own personal work. The supervisor should not be involved beyond general support and guidance, and is not allowed to correct the completed report before submission, except for general recommendations.

The project report must be typed and must be submitted in myCourses in the original word-processing format and as a PDF file. If the report is submitted directly to the project supervisor, please notify the course coordinator of that fact.

Tips

There is no one search engine that fully covers both biomedicine and engineering. The Library maintains resource pages for both Bioengineering and Biomedical Engineering at https://libraryguides.mcgill.ca/. Google Scholar may be useful as starting point but other databases should also be consulted. Wikipedia articles must be treated with caution and their use as references is discouraged. If a Web page is used as a reference, the page title and date accessed must be provided.

You must not cite a source unless you've read it yourself, unless you explicitly say 'as cited by' either in the text or in the list of references. Use specialized software for your list of references (e.g., Zotero, Mendeley, EndNote, Reference Manager). Every year, some students fail to properly format the list of references and ended up being penalized needlessly.

Please follow a logical organization for your paper:

- Title page
- Table of contents (optional)
- Abstract (optional)
- Introduction (who? what? where? why?)
- Background (short review of the relevant historical background, i.e., previous work)
- Body (with appropriate section heading(s), not 'Body')
- Conclusion (summarize and discuss results and identify priorities for future work)
- References (references must include the titles)

Possible topics

Possible project topics (and supervisors) include but are not limited to the following:

- 'Wet' biological and biomedical engineering
    - Controlled drug delivery (Prakash)
    - Biomaterials (Tabrizian)
    - Reduction of white blood cell contamination in circulating tumour cell isolation technologies (Juncker)

- ↘ Recent 2D and 3D patterning techniques to study cell navigation (Juncker)
- ↘ Recent advances in single-cell RNA detection (Juncker)
- ↘ Signal amplification techniques for point-of-care diagnostic tests (Juncker)
- ↘ Microfluidic and miniaturized antibiotic susceptibility screening techniques (Juncker)
- ↘ Electrochemical nanobiosensors (Mahshid)
- ↘ Immunology of laryngeal diseases (Li-Jessen)
- ↘ Advances in biomanufacturing of gene and cell therapy vectors (Kamen)
- ↘ Biomanufacturing of viral vaccines for emerging infectious diseases (Kamen)
- ↘ Engineering lipid membrane composition for biotechnological applications (Ignea)
- ↘ Synthetic biology approaches for production of terpenoids in yeast (Ignea)
- ↘ Tissue engineering approaches in bone defect healing (Willie)
- ↘ Characterization of biological gels (C Wagner)
- ↘ Nanomaterials for genome editing (Chen)

❿ Biomedical imaging

- ↘ Magnetization transfer imaging of cerebral myelin (Tardif)
- ↘ MR relaxometry of the brain – methods and applications (Tardif)
- ↘ Non-cartesian MR imaging (Tardif)
- ↘ MRI acquisition (Tardif)
- ↘ Magnetic resonance imaging: technology and techniques (Levesque)
- ↘ MR image reconstruction (Levesque)
- ↘ Dynamic contrast-enahnced MRI (Levesque)
- ↘ Quantitative susceptibility MRI (Levesque)
- ↘ MEG versus EEG: Two complementary views of electrophysiology (Grova)
- ↘ NIRS versus fMRI: Two complementary views of hemodynamic processes (Grova)
- ↘ Source localization in electrophysiology (Grova)
- ↘ Optical imaging of hemodynamic processes (Grova)
- ↘ Image-guided surgery (Collins)
- ↘ Image classification and segmentation (Collins)
- ↘ Image segmentation for 3-D finite-element modelling (Funnell)
- ↘ Image-based 3-D modelling in medical education (Funnell)
- ↘ Micro-computed tomography of mineralized tissues (Willie)
- ↘ X-ray tomography (Reznikov)
- ↘ Image segmentation and processing (Reznikov)

❿ Biomedical control systems, signal analysis, and modelling

- ↘ Linear filter models of visual neurons – their power and their limitations (Baker)
- ↘ System identification in neurophysiology (Baker)
- ↘ Muscle as an actuator (Kearney)
- ↘ Stretch reflexes: What do they really do? (Kearney)
- ↘ Neuromuscular control of joints (Kearney)
- ↘ Detection and analysis of heart rate and its variability (Kearney)
- ↘ Calibration of respiratory impedance plethysmography (Kearney)
- ↘ Functional electrical stimulation for restoring muscle function (Kearney)
- ↘ Closed-loop control in biomedical applications [specific area is flexible] (Haidar)
- ↘ Neuronal mechanisms of resting-state functional MRI (Shmuel)
- ↘ Neuronal mechanisms of negative functional MRI responses (Shmuel)
- ↘ Computational modelling of wound repair (Li-Jessen)
- ↘ Machine learning analysis of vocal health and fatigue (Li-Jessen)
- ↘ EEG correlates of consciousness (Blain-Moraes)
- ↘ Network analysis of EEG (Blain-Moraes)

- ↘ Physics-informed neural networks (Funnell)
- ↘ Mathematical disease models (C Wagner)
- ↘ Pattern formation in living organisms and biological systems (Reznikov)

❿ Biomechanics

- ↘ Finite-element modelling of the ear (Funnell)
- ↘ Active and passive middle-ear prostheses (Funnell)
- ↘ Non-invasive diagnostic tests for hearing loss (Funnell)
- ↘ Haptics in medical education (Funnell)
- ↘ Biomechanics of vascular tissues (Leask)
- ↘ Cellular biomechanics (Leask)
- ↘ Vocal fold mechanobiology (Li-Jessen)
- ↘ Skeletal mechanobiology (Willie)
- ↘ Bone adaptation to mechanical loading (Willie)
- ↘ Skeletal biology (Reznikov)