

**Western University
School of Biomedical Engineering**

BME 9502B: Biomedical Systems Analysis

Course Outline 2019-20

Course Description: An introduction to biomedical engineering organized around applications of linear and control systems analysis to the dynamics of physiological systems and their responses to diagnostic and therapeutic interventions. Emphasis is placed on cardiovascular, respiratory, and neuromuscular physiology and interactions of those systems with medical devices. Assignments make use of numerical models implemented in MATLAB.

Instructor: Dr. James Lacefield
ACEB 2405D, 519-661-2111 ext. 84303, jlacefie@uwo.ca
Consultation hours: To be announced

Contact Hours: 3 lecture hours, 0.5 course.

Antirequisite: ECE 4455A/B or MEDBIO 4455A/B.

Prerequisites: Registration in an engineering or science graduate program. Familiarity with engineering applications of Fourier and Laplace analysis is recommended.

Lecture Schedule and Location: Mondays and Wednesdays, 9:30 – 10:20 am, Fridays 12:30 – 1:20 pm, ACEB 1415, beginning Monday, January 6, 2020.

Required Textbook: No required textbook. Recommended references will be placed on reserve at Taylor Library and posted to the course OWL site.

Topics

1. Cardiac electrophysiology and implantable cardioverter defibrillators
2. Cardiovascular mechanics and left ventricular assist devices
3. Respiratory mechanics and mechanical ventilation
4. Respiratory regulation and diagnosis of unstable periodic breathing
5. Neuromuscular control and upper-limb neural prosthetics

Learning Objectives

1. Students will be able to explain the physiological and biophysical basis of biomedical systems models and analyze those models using concepts from linear systems and control theory that are common to most engineering disciplines.
2. Students will be able to demonstrate the use of biomedical systems models to inform the design of medical devices and diagnostic algorithms.

3. Students will be able to employ engineering software tools to investigate the dynamic behaviour of biomedical systems models.
4. Students will be able to independently investigate and critique hypotheses and conclusions presented in primary-source biomedical engineering and physiology literature.
5. Students will be able to identify ethical issues arising from development of medical technology and use of biomedical models to make decisions about public health or safety issues.

Evaluation

| Course Component | Weight |
|-----------------------------|--------|
| Homework Assignments | 45% |
| Minute Papers | 5% |
| Course Project Proposal | 5% |
| Course Project Final Report | 45% |

Homework Assignments: The course will include four homework assignments that will require students critique assigned readings from biomedical engineering or physiology journals and investigate the behaviour of relevant systems models implemented in MATLAB. The readings and MATLAB models will be distributed via OWL. Homework assignments must be submitted electronically to the course OWL site.

Each homework assignment consists of two parts: short-answer questions about background knowledge relevant to the case study and a computational investigation of issues raised by the case using the MATLAB systems models. The MATLAB investigation components of the assignments will each include one or two lecture sessions devoted to use and discussion of the MATLAB systems models. Students should bring a laptop, tablet, or other device with MATLAB installed to these class sessions. **Students must be present for and participate in these in-class discussions to receive credit for the MATLAB investigation component of a homework assignment.** A schedule of the in-class MATLAB investigations will be posted on OWL at the beginning of the term.

Minute Papers: Two lecture sessions will be devoted to class discussions of ethical issues related to selected case studies. At the end of those discussions, students will complete “minute papers”, which are brief written responses to the class discussions. **Students must be present for these in-class discussions to have an opportunity to submit minute papers.** A schedule of in-class ethics discussions will be posted on OWL at the beginning of the term.

Course Project: In lieu of a final examination, each student will perform an independent computational modeling project selected in consultation with the instructor and submit a written report describing the project. A one-page **project proposal** must be submitted electronically through OWL by **March 9**. The **project final report** will also be submitted electronically through OWL and will be due on **April 27**. Additional information about project requirements will be posted on the course OWL site.

Late Submission Policy:

The first part of each homework assignment (short-answer questions) will be due 15 minutes before the start of the corresponding MATLAB investigation classroom session. Late submissions of short-answer responses will not be accepted because the purpose of those questions is to prepare students to participate in the classroom portion of the MATLAB investigation.

The second part of each homework assignment (results of the MATLAB investigation) will be accepted without penalty until the end of a grace period lasting 24 hours after the posted due date. MATLAB investigations submitted more than 24 hours late will receive no credit unless alternate arrangements are agreed to *in advance* by the instructor.

Minute papers will be handwritten in class and must be submitted at the end of that class period. Late submissions of minute papers will not be accepted.

Use of English: In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for improper use of English. Additionally, poorly written work with the exception of the final examination may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

Cheating and Plagiarism: Students must write their essays and assignments in their own words. Whenever students take an idea or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. University policy states that cheating, including plagiarism, is a scholastic offence. The commission of a scholastic offence is attended by academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning.

Use of Electronic Devices: Students may use laptop or tablet computers during lectures *only* to access the course OWL site or other information relevant to the course material or to run MATLAB during in-class computational investigations. No other electronic devices (e.g., cell phones, MP3 players) may be used during lectures.

Internet and Electronic Mail: Students are responsible for regularly checking their Western e-mail and the course web site (<https://owl.uwo.ca/portal/>) and making themselves aware of any information that is posted about the course.

Accessibility: Western is committed to achieving barrier-free accessibility for all its members, including graduate students. As part of this commitment, Western provides a variety of services devoted to promoting, advocating, and accommodating persons with disabilities in their respective graduate program. Graduate students with disabilities (for example, chronic illnesses, mental health conditions, mobility impairments) are encouraged to register with Student Accessibility Services (SAS), a confidential service designed to support graduate and undergraduate students through their academic program. With the appropriate documentation, the student will work with both SAS and their graduate programs (normally their Graduate Chair and/or course instructor) to ensure that appropriate academic accommodations to program requirements are arranged. These accommodations include individual counselling, alternative formatted literature, accessible campus transportation, learning strategy instruction, writing exams and assistive technology instruction. For more information, see <http://www.sdc.uwo.ca/ssd/>.

As part of a successful graduate student experience at Western, we encourage students to make their health and wellness a priority. Western provides several on campus health-related services to help you achieve optimum health and engage in healthy living while pursuing your graduate degree. For example, to support physical activity, all students, as part of their registration, receive membership in Western's Campus Recreation Centre. Numerous cultural events are offered throughout the year; for example, please visit the Faculty of Music web page, <http://www.music.uwo.ca/>, and our own McIntosh Gallery, <http://www.mcintoshgallery.ca/>.

Information regarding health- and wellness-related services available to students may be found at <http://www.health.uwo.ca/>. Students seeking help regarding mental health concerns are advised to speak to someone they feel comfortable confiding in, such as their faculty supervisor, their program director (graduate chair), or other relevant administrators in their unit. Campus mental health resources may be found at <https://www.uwo.ca/health/psych/index.html>.