

**Western University
Faculty of Engineering
Department of Electrical and Computer Engineering**

**ECE 4455A/B: Biomedical Systems Analysis
Course Outline 2023-24**

Description/Academic Calendar Copy: 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 will be placed on respiratory and cardiovascular physiology and interactions of those systems with medical devices. Numerical models will be used to investigate these topics.

Contact Hours: 3 lecture hours, 0.5 course.

Antirequisite: MEDBIO 4455A/B.

Prerequisites: (CBE 2221A/B or ECE 2233A/B or ECE 3374A/B or MSE 2233A/B) and (CBE 3310 A/B or ECE 3330A/B or MME 3350A/B).

Unless you have either the prerequisites for this course or written special permission from your Dean to enroll in it, you will be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

CEAB Academic Units: Engineering Science 75%, Natural Science 25%.

Required Textbook: No required textbook. Required and recommended references will be posted to the course OWL site.

General Learning Objectives (CEAB Graduate Attributes)

Knowledge Base	D	Use of Engineering Tools	D	Impact on Society and the Environment	D
Problem Analysis	A	Individual and Team Work		Ethics and Equity	
Investigation	D	Communication Skills	A	Economics and Project Management	

Design		Professionalism		Life-Long Learning	D
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[**I** (introduce): The instructor will introduce the topic at the level required. It is not necessary for the student to have seen the material before. **D** (develop): There may be a reminder or review, but the student is expected to have seen and been tested on the material before taking the course. **A** (apply): It is expected that the student can apply the knowledge without prompting (e.g., no review).]

Course Topics and Specific Learning Outcomes	CEAB Graduate Attributes Indicators
<p>1. Cardiac Electrophysiology and Implantable Cardioverter Defibrillators</p> <p>At the end of this section, students will be able to:</p> <ol style="list-style-type: none"> Understand the engineering considerations used to specify the stimulus waveform produced by an implantable defibrillator. Demonstrate the use of a linear time-invariant biomedical systems model to optimize key design parameters for a medical device. Identify and evaluate ethical issues arising from the use of biomedical systems models to make decisions about public health or safety risks. Develop and apply their own strategies for critical evaluation of scientific and engineering publications. 	<p>KB3, KB4</p> <p>PA3, I3, ET2, CS2</p> <p>IESE1, CS2</p> <p>LL2 (taught but not assessed)</p>
<p>2. Cardiovascular Mechanics and Left Ventricular Assist Devices</p> <p>At the end of this section, students will be able to:</p> <ol style="list-style-type: none"> Understand the engineering science principles governing hemodynamic interactions between the cardiovascular system and a left ventricular assist device. Apply Euler's method for numerical analysis of a time-varying system. Employ a biomedical systems model to analyze physiological interactions between a patient and a medical device. 	<p>KB3, KB4</p> <p>PA2</p> <p>PA3, I3, ET2, CS2</p>
<p>3. Respiratory Mechanics and Mechanical Ventilation</p> <p>At the end of this section, students will be able to:</p> <ol style="list-style-type: none"> Understand the fluid mechanical properties of the respiratory system that determine pulmonary airflow. 	<p>KB3, KB4</p>

b. Apply Euler's method for numerical analysis of a nonlinear system.	PA3, I3, ET2, ET3, CS2
c. Identify and evaluate ethical and safety issues arising from scenarios that require allocation of scarce medical resources.	IESE1, CS2
4. Respiratory Regulation and Pathophysiology of Unstable Periodic Breathing	
At the end of this section, students will be able to:	
a. Understand the application of control systems principles to analysis of respiratory regulation.	KB3, KB4
b. Use MATLAB's Control Systems Toolbox to determine the relative stability of a closed-loop system with feedback delays.	ET2
c. Employ a biomedical systems model to explain the mechanism of an abnormal response to a physiological stimulus.	PA3, I3, CS2

Evaluation

Course Component	Weight
Homework Assignments	35%
Quizzes	20%
Minute Papers	5%
Final Project	40%

Homework Assignments: Three case-based homework assignments will require students to 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.

For each assignment, two lecture sessions will be devoted to use and discussion of the MATLAB systems models. Students are expected to bring a laptop, tablet, or other device with MATLAB installed and available for their use during these sessions. A schedule of the MATLAB class sessions will be posted on OWL at the beginning of the term.

Quizzes: Four quizzes consisting of multiple-choice and fill-in-the-blank questions will assess students' understanding of background knowledge concepts relevant to the case studies. These quizzes will be administered asynchronously via OWL. Each quiz will be available to students for at least 72 hours. Each quiz may be submitted twice; the higher mark will be recorded. A schedule of quiz deadlines 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 discussions to have an opportunity to submit minute papers.** A schedule of ethics discussions will be posted on OWL at the beginning of the term.

Final Project: A final project will be due on **December 16**. The project will focus on the assigned journal article and MATLAB investigation for the fourth case study. The MATLAB code and instructions for the project will be available to students for at least two weeks prior to the due date.

Late Submission Policies: All assessments will be due at 11:55 pm on their due date unless otherwise specified.

Homework assignments will be accepted without penalty until the end of a grace period lasting 24 hours after the posted due date. Homework assignments submitted more than 24 hours late will receive no credit unless alternate arrangements are agreed to *in advance* by the instructor.

The OWL quiz tool will not permit late submission of quizzes.

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

If a student submits an illness self-report or receives an accommodation for a missed quiz or minute paper, the weight of that assessment will be transferred to the final project.

Late submissions of the final project will not be accepted.

Faculty of Engineering and Western Academic Policies

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.

Attendance: Any student who, in the opinion of the instructor, is absent too frequently from class, laboratory, or tutorial periods will be reported to the Dean (after due warning has been given). On the recommendation of the department, and with the permission of the Dean, the student will be debarred from taking the regular final examination in the course.

Absence Due to Illness or Other Circumstances: Students should immediately consult with the instructor or department Chair if they have any problems that could affect their performance in the course. Where appropriate, the problems should be documented (see the attached “Instructions for Students Unable to Write Tests or Examinations or Submit Assignments as Scheduled”). The student should seek advice from the instructor or department Chair regarding how best to deal with the problem. Failure to notify the instructor or department Chair immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

For more information concerning academic accommodations for absences, see the relevant section of the Senate Academic Policies:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_medical.pdf

For more information concerning accommodations for religious holidays, see the relevant section of the Senate Academic Policies:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_religious.pdf

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.

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, in the relevant section of the Senate Academic Policies:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf

Use of Electronic Devices: Students may use laptop or tablet computers during in-person 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.

Policy on Repeating All Components of a Course: Students who are required to repeat an Engineering course must repeat all components of the course. No special permissions will be granted enabling a student to retain laboratory, assignment, or test marks from previous years. Previously completed assignments and laboratories cannot be resubmitted by the student for grading in subsequent years.

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

Accessibility: Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Student Accessibility Services (SAS) at 519-661-2147 or ssd@uwo.ca for any specific question regarding an accommodation.

Support Services: Office of the Registrar, <http://www.registrar.uwo.ca/>
Student Development Centre, <http://www.sdc.uwo.ca/>

Engineering Undergraduate Services, <http://www.eng.uwo.ca/undergraduate/>
USC Student Support Services, <http://westernusc.ca/your-services/>

Students who are in emotional/mental distress should refer to Mental Wellbeing @ Western, https://www.uwo.ca/health/mental_wellbeing/, for a complete list of options about how to obtain help.

Western is committed to reducing incidents of gender-based and sexual violence and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced sexual or gender-based violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts at:

https://www.uwo.ca/health/student_support/survivor_support/get-help.html.

To connect with a case manager or set up an appointment, please contact support@uwo.ca.

Non-Discrimination/Harassment Policy: Western is committed to providing a learning and working environment that is free of harassment and discrimination. All students, staff, and faculty have a role in this commitment and have a responsibility to ensure and promote a safe and respectful learning and working environment. Relevant policies include Western's [Non-Discrimination/Harassment Policy](#) and [Non-Discrimination/Harassment Policy – Administrative Procedures](#).

Any student, staff, or faculty member who experiences or witnesses behaviour that may be harassment or discrimination must report the behaviour to the Western's Human Rights Office. Harassment and discrimination can be human rights-based, which is also known as EDI-based (sexism, racism, transphobia, homophobia, Islamophobia, xenophobia, antisemitism, and ableism), or non-human rights-based (personal harassment or workplace harassment).

STATEMENT ON GENDER-BASED AND SEXUAL VIOLENCE

Western [is committed to reducing incidents of gender-based and sexual violence](#) and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced gender-based or sexual violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts, [here](#). To connect with a case manager or set up an appointment, please contact support@uwo.ca.

INSTRUCTIONS FOR STUDENTS UNABLE TO WRITE TESTS OR EXAMINATIONS OR SUBMIT ASSIGNMENTS AS SCHEDULED

If, on medical or compassionate grounds, you are unable to write term tests or final examinations or complete course work by the due date, you should follow the instructions listed below. You should understand that academic relief will not be granted automatically on request. You must demonstrate to your department (or the Undergraduate Services Office) that there are compelling medical or compassionate grounds that can be documented before academic relief will be considered. Different regulations apply to term tests, final examinations and late assignments. Please read the instructions carefully.

A. GENERAL REGULATIONS & PROCEDURES

1. All first-year students will report to the Undergraduate Services Office by submitting the [Academic Consideration Request Form](#), for all instances.
2. If you are an upper year student and you are missing a test/assignment/lab or examination you will report the absence by submitting [Academic Consideration Request Form](#). Absences worth LESS THAN 10% of your mark, will be processed by your department office. If your course work is worth 10% OR MORE of your final grade, your request will be processed by the Undergraduate Services Office.
3. Check the course outline to see if the instructor has a policy for missed tests, examinations, late assignments or attendance.
4. Documentation must be provided as soon as possible. If no one is available in your department office or the Undergraduate Services Office, leave a message clearly stating your name & student number and reason for your call. The department telephone numbers are given at the end of these instructions.
5. If you decide to write a test or an examination you should be prepared to accept the mark you earn. Rewriting tests or examinations or having the value of a test or examination reweighted on a retroactive basis is not permitted.

B. TERM/MIDTERM TESTS

1. If you are in first year and you are unable to write a midterm/term test, contact the Undergraduate Services Office, SEB 2097 PRIOR to the scheduled date of the test.
2. If you are an upper year student and you are unable to write a midterm/term test, inform your instructor PRIOR to the scheduled date of the test and request relief through the [Academic Consideration Request Form](#). If the instructor is not available, leave a message for him/her at the department office. If the test is worth LESS THAN 10% of your mark, your request for relief will be processed by your department office. If the test is worth MORE THAN 10% of your final grade your request for relief will be processed by the Undergraduate Services Office.
3. Be prepared to attach supporting documentation to the Department Chair and/or the Undergraduate Services Office through the online form (see next page for information on documentation).
4. Discuss with the instructor if and when the test can be rescheduled. The approval of the Chair or the Undergraduate Services Office is required when rescheduling midterm/term tests.

C. FINAL EXAMINATIONS

1. If you are unable to write a final examination, contact the Undergraduate Services Office PRIOR TO THE SCHEDULED EXAMINATION TIME to report your absence using the [Academic Consideration Request Form](#) and request permission to write a Special Final Examination. If no one is available in the Undergraduate Services Office, leave a message clearly stating your name & student number.
2. Be prepared to provide the Undergraduate Services Office with supporting documentation (see next page for information on documentation) the next day, or as soon as possible (in cases where students are hospitalized). The following circumstances are not considered grounds for missing a final examination or requesting special examinations: common cold, headache, sleeping in, misreading timetable and travel arrangements.
3. In order to receive permission to write a Special Examination, you must obtain the approval of the Chair of the Department **and** the Associate Dean and in order to apply you must submit an "[Application for a Special Exam](#)" form. The Undergraduate Services Office will then notify the course instructor(s) and reschedule the examination on your behalf.

PLEASE NOTE: It is the student's responsibility to check the date, time and location of the Special Examination.

D. LATE ASSIGNMENTS

1. Advise the instructor if you are having problems completing the assignment on time (**prior** to the due date of the assignment).
2. Be prepared to submit the [Academic Consideration Request Form](#) and provide documentation if requested by the instructor (see reverse side for information on documentation).
3. If you are granted an extension, establish a due date. The approval of the Chair of your Department (or the Assistant Dean, First Year Studies, if you are in first year) is not required if assignments will be completed prior to the last day of classes.
4.
 - i) Extensions beyond the end of classes must have the consent of the instructor, the department Chair and the Associate Dean, Undergraduate Studies. Documentation is mandatory.
 - ii) A Recommendation of Incomplete Form must be filled out indicating the work to be completed and the date by which it is due. This form must be signed by the student, the instructor, the department Chair and the Associate Dean, Undergraduate Studies.

E. SHORT ABSENCES

If you miss a class due to a minor illness or other problem, check your course outlines for information regarding attendance requirements and make sure you are not missing a test, laboratory or assignment. Cover any readings and arrange to borrow notes from a classmate.

F. EXTENDED ABSENCES

If you are absent more than one week or if you get too far behind to catch up, you should consider reducing your workload by dropping one or more courses. (Note drop deadlines listed below). You are strongly encouraged to seek advice from your Academic Counsellor in the Undergraduate Services Office.

G. DOCUMENTATION

If you consulted an off-campus doctor or Student Health Services regarding your illness or personal problem, **you must provide the doctor with a Student Medical Certificate** to complete at the time of your visit and then bring it to the Department (or the Undergraduate Services Office). **This note must contain the following information: severity of illness, effect on academic studies and duration of absence. Regular doctor's notes will not be accepted; only the Student Medical Certificate will be accepted.**

In Case of Serious Illness of a Family Member: Provide a Student Medical Certificate to your family member's physician to complete and bring it to the Department (or the Undergraduate Services Office if you are in first year).

In Case of a Death: Obtain a copy of the death certificate or the notice provided by the funeral director's office. You must include your relationship to the deceased and bring it to the Department (or the Undergraduate Services Office if you are in first year).

For Other Extenuating Circumstances: If you are not sure what documentation to provide, ask the Departmental Office (or the Undergraduate Services Office if you are in first year) for direction.

Note: Forged notes and certificates will be dealt with severely. To submit a forged document is a scholastic offence (see below).

H. ACADEMIC CONCERNS

1. You need to know if your instructors have a policy on late penalties, missed tests, etc. This information may be included on the course outlines. If not, ask your instructor(s).
2. **You should also be aware of attendance requirements in some courses. You can be debarred from writing the final examination if your attendance is not satisfactory.**
3. If you are in academic difficulty, check out the minimum requirements for progression in the calendar. If in doubt, see your Academic Counsellor.

Calendar References: Check these regulations in your 2023 Western Academic Calendar available at www.westerncalendar.uwo.ca.

Absences Due to Illness:

https://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_13_5

Academic Accommodations for Students with Disabilities:

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_10

Academic Accommodations for Religious or Holy Days:

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_16

Course Withdrawals:

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=6&SelectedCalendar=Live&ArchiveID=#Page_75

Examinations:

<http://www.westerncalendar.uwo.ca/PolicyPages.cfm?PolicyCategoryID=5&command=showCategory&SelectedCalendar=Live&ArchiveID=#>

Scheduling of Term Assignments:

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=5&SelectedCalendar=Live&ArchiveID=#SubHeading_78

Scholastic Offences:

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_20

Student Medical Certificate:

<https://www.eng.uwo.ca/files/undergraduate/student-medical-certificate.pdf>

Engineering Academic Regulations:

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=4&SelectedCalendar=Live&ArchiveID=#Page_86

Note: These instructions apply to all students registered in the Faculty of Engineering regardless of whether the courses are offered by the Faculty of Engineering or other faculties in the University.

Add Deadlines:

First term half course (i.e. “A” or “F”)	September 15, 2023
Full courses and full-year half course (i.e. “E”, “Y” or no suffix)	September 15, 2023
Second term half course (i.e. “B” or “G”)	January 16, 2024

Drop Deadlines:

First term half course without penalty (i.e. “A” or “F”)	November 13, 2023
Full courses and full-year half courses without penalty (i.e. “E”, “Y” or no suffix)	November 30, 2023
Second term half or second term full course without penalty (i.e. “B” or “G”)	March 7, 2024

Contact Information:

Undergraduate Services Office:	SEB 2097 Phone: 519-661-2130	E-mail: engugrad@uwo.ca
Chemical & Green Process Engineering:	TEB 477 Phone: 519-661-2131	E-mail: cbeugrad@uwo.ca
Civil Engineering:	SEB 3005 Phone: 519-661-2139	E-mail: civil@uwo.ca
Computer, Electrical, Mechatronic Systems & Software Engineering	TEB 279 Phone: 519-661-3758	E-mail: eceugrad@uwo.ca
Integrated Engineering	ACEB 2410 Phone: 519-661-6725	E-mail: engceli@uwo.ca
Mechanical Engineering:	SEB 3002 Phone: 519-661-4122	E-mail: mmeundergraduate@uwo.ca