WESTERN UNIVERSITY
FACULTY OF ENGINEERING
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

ECE3330A – CONTROL SYSTEMS
COURSE OUTLINE Fall 2025

Description: This is an introductory course that focuses on the theory of linear control system design and analysis. The course emphasises the analysis of dynamic behaviour and the design of feedback control strategies to meet specific system performance criteria. Familiarity with Laplace transform and Bode plots is assumed.

Academic Calendar: The concept of feedbacks; modelling of dynamic systems; characteristics of feedback control systems, performance of control systems in time and frequency domains; stability of feedback systems; control system analysis and design; using root locus and frequency response techniques.
https://www.westerncalendar.uwo.ca/Courses.cfm?CourseAcadCalendarID=MAIN_015052_1&SelectedCalendar=Live&ArchiveID=

Contact Hours: 3 lecture hours, 5 laboratory sessions, 3 hours each, 0.5 course.

Prerequisites: NMM 2270A/B or the former Applied Mathematics 2270A/B and (ECE 2233A/B or MSE 2233A/B).
Unless you have either the requisites for this course or written special permission from your Dean to enrol 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.

Antirequisite: CBE 3310A/B

CEAB Academic Units: Engineering Science 75% Engineering Design 25%

Contact Hours:
Lecture: Weekly starting January 8 on Mondays and Fridays (Section 1), and Tuesdays and Wednesdays (Section 2)
Laboratory: Bi-weekly starting TBA. Each lab is 3 hours long and there are 4 labs during the term.

Textbook (Required): N. S. Nise, Control Systems Engineering, 6th, 7th or 8th Ed., Wiley.

Software (Required): Matlab and Simulink including Control Systems and Simscape toolboxes

Recommended Reference:
1. G.F. Franklin, J.P. Powell and A. Emani-Naeini, Feedback Control of Dynamic Systems, Fourth Ed., Prentice Hall, 2002.
2. R.C. Dorf and R.H. Bishop, Modern Control Systems, Ninth Edition, Addison Wesley, 2000.

GENERAL LEARNING OBJECTIVES

Knowledge Base	D	Use of Engineering Tools	D	Impact on Society and the Environment	
Problem Analysis	**D**	Individual and Team Work		Ethics and Equity	
Investigation		Communication		Economics and Project Management	
Design	**D**	Professionalism		Life-Long Learning	

Notation: **I –**The instructor will introduce the topic at the level required. It is not necessary for the student to have seen the material before. **D –** 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 –** It is expected that the student can apply the knowledge without prompting (e.g. no review)**a/b**, where **a** is the cognitive level (1: Remember, 2: Understand, 3: Apply) at which the attribute is assessed and **b** is the academic level (1: Beginner, 2:

Intermediate, 3: Advanced) at which the attribute is assessed.

Course Materials: Weekly content and guides for the laboratories will be available on the course OWL site. The material for this course will be taught in both lectures and labs; therefore, it is imperative that you attend each lecture and lab.

Units: SI

Course Topics:

1. Introduction to Control Systems and Mathematical Modeling of Dynamic Systems
   - Examples of control systems
   - Concept of feedback
   - Elements in control systems
   - The design process
   - Physical system modeling
   - Laplace transform review
2. Time Response
   - Poles, zeros, and system responses
   - First-order systems
   - Second-order systems
   - The relationship between 's'-plane root location and transient response
3. Multiple Systems Representation
   - Block diagrams and block diagram simplification
   - Signal-flow graph
   - Mason's rule
4. Stability
   - Concept of stability
   - Routh-Hurwitz stability criterion
   - Steady-state error
   - Sensitivity
5. Root Locus Analysis
   - Concept of root locus
   - Rules in the construction of root locus
   - Analysis of control systems using root locus
6. Frequency Response Analysis and Design
   - Bode diagrams
   - Gain and phase margins
   - Frequency domain performance specifications
   - Stability tests in frequency domain
   - Lead-lag compensator designs

Specific Learning Outcomes: The following table summarizes the course learning outcomes along with CEAB GAIs where the GAIs in bold indicate ones to be measured and reported annually.

1. At the end of topic 1, students should be able to:
   - Identify the basic elements in a feedback control system, including labs; **PA1**,ET1
   - Sketch the block diagram representation of a DC motor system; **KB1,PA2**
   - Convert time-domain functions to s-domain by using Laplace Transform; **PA1,PA2**
   - Write system transfer functions from block diagram representations; **PA2**

2. At the end of topic 2, students should be able to:
   - Calculate the time constant of a first-order system; **PA2**

- Determine the rise time, percent of overshoot, and settling time of a second-order system; — PA1,ET2 KB3
- Distinguish the steady-state from the transient responses of a dynamic system; — PA2
- Relate the transient responses of a dynamic system to the pole location in the s-plane — PA2

3. At the end of topic 3, students should be able to:
   - Reduce a complex block diagram to a single block diagram and obtain equivalent transfer function — PA2,PA3 KB4
   - Convert block diagram to signal-flow graph — PA1
   - Obtain transfer function of a complex system using one formula — PA3

4. At the end of topic 4, students should be able to:
   - Sketch the typical responses from stable, critically stable, and unstable systems — PA2
   - Apply the Routh-Hurwitz criterion to determine the stability region of a system — PA3, KB3

5. At the end of topic 5, students should be able to:
   - Explain the concept of root locus — PA1
   - Apply four main rules in constructing a root locus for a given system, including labs and MATALB — PA2, ET2, KB4
   - Analyze the effect of the control system gain on the system performance using root locus — PA2, PA3

6. At the end of topic 6, students should be able to:
   - State the frequency domain specifications for a feedback control system — PA1
   - Perform the stability test in frequency domain — PA2, KB3
   - Distinguish a phase-lead compensator from a phase-lag compensator — D2,D3
   - Synthesize a phase-lead or a phase-lag compensator for a given dynamic system — D2,D3

Evaluation:

Course Component	Weight	Assigned	Due Date	CEAB GAs Assessed
Assignments	0%			
Laboratory	15%			
Quiz (2 quizzes)	30%	Designated		PA1, PA2
Final Examination	55%			PA2, PA3

To obtain a passing grade in the course, a mark of 50% or more must be achieved on the final examination as well as on the laboratory. A final examination or laboratory mark < 50% will result in a final course grade of 48% or less.

Note that the dates listed above are tentative and may be adjusted if needed. Marks will be assigned on the basis of method of analysis and presentation, correctness of solution, clarity and neatness.

Assignments: Assignments are posted on course online portal. Although, Assignments will not be used as a means of student's assessment in the course, Assignments provide important information that complements the learning experience and enrich student's understanding of each topic. Students must use Assignments as a tool for evaluating their knowledge and understanding of each topic. Solutions to selected number of questions (not all questions) in each Assignment will be posted about one week after each Assignment is posted.

Laboratory: The lab consists of four MATLAB/Simulink based exercises. Each requires pre-lab work, which must be

completed individually and submitted as a single PDF to OWL before the lab session. Late submissions for pre-laboratory work are **not accepted**.
Students work in fixed pairs throughout the semester, and both must attend all labs. During each session, the group must complete every section, demonstrate results to the TA, and answer questions before proceeding. Grades depend on the pre-lab submission and in-lab performance, including demonstrated results and responses to TA questions.

Thorough pre-lab preparation ensures efficient lab completion, as no extra time is given. Students who finish early may leave, while incomplete work earns partial credit based on submitted pre-lab work and completed sections.

If a group member is **absent or over an hour late**, the remaining student must finish the lab. The absent student faces a 40% penalty unless they provide official documentation through the Undergraduate Office.

Quiz: The course includes a **two-part quiz**, consisting of Quiz 1 and Quiz 2. The **two-part quiz** is a **designated exam**. Both parts will be administered during scheduled lecture times, **pending classroom availability**. Specific dates and times for each quiz will be announced on the course website at least one week in advance. These closed-book assessments may contain multiple-choice questions, calculation problems, or a combination of both.

There will be **no make-up** opportunities for missed quiz components. Students who miss either Quiz 1 or Quiz 2 must submit documentation through the Academic Consideration for Student Absence process. The department will then determine whether to reweight the missed component(s) to the final exam. Failure to provide proper documentation will result in a zero for the missed quiz part.

Students anticipating an absence for religious observances must notify the undergraduate office in advance to make appropriate arrangements. Without such notification, students remain responsible for completing the quiz as scheduled.

Final Examination: The final exam will take place during the regular examination period. The final exam will be closed book from all covered topics. Necessary equations are provided. Only non-programmable calculators are allowed. (check https://studentservices.uwo.ca/secure/Exams/). Final Examination in this course will be conducted in person, unless decided otherwise.

Late Submission Policy: Late submissions **for pre-laboratory work or other course deliverables are not accepted**. It is the student's responsibility to make all on-line submissions have been done properly and the uploaded files are free of errors.

Use of English Policy: In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for the 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.

All work will be marked first for content after which a penalty not to exceed the maximum shown above may be applied for lack of proficiency in English and/or presentation.

Attendance: Attendance is mandatory for all lectures and labs.

Any student who, in the opinion of the instructor, has not engaged sufficiently in class lectures and/or is absent too frequently will be reported to the Dean. 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.

Academic Consideration for Student Absence: Students will have up to two (2) opportunities during the regular academic year to use an on-line portal to self-report an absence during the term, provided the following conditions are met: the absence is no more than 48 hours in duration, and the assessment for which consideration is being sought is worth 30% or less of the student's final grade. Students are expected to send an email to the instructor within 24 hours of the end of the

period of the self-reported absence. You **do not need to receive the instructor's acknowledgment** for the self-reporting absence. Students are not able to use the self-reporting option in the following circumstances:

- for exams scheduled by the Office of the Registrar (e.g., December and April exams)
- absence of a duration greater than 48 hours,
- assessments worth more than 30% of the student's final grade,
- if a student has already used the self-reporting portal twice during the academic year

If the conditions for a Self-Reported Absence are not met, students will need to provide a Student Medical Certificate if the absence is medical, or provide appropriate documentation if there are compassionate grounds for the absence in question. Students are encouraged to contact their Faculty academic counselling office to obtain more information about the relevant documentation.

Students should also note that individual instructors are not permitted to receive documentation directly from a student, whether in support of an application for consideration on medical grounds, or for other reasons. All documentation required for absences that are not covered by the Self-Reported Absence Policy must be submitted to the Academic Counselling office of a student's Home Faculty.

For Western University policy on Consideration for Student Absence, see
Policy on Academic Consideration for Student Absences - Undergraduate Students in First Entry Programs
and for the Student Medical Certificate (SMC), see:
http://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf.

Students should consult the University's list of recognized religious holidays, and should give reasonable notice in writing, prior to the holiday, to the Instructor and an Academic Counsellor if their course requirements will be affected by a religious observance. Additional information is given in the Western Multicultural Calendar.

For more information concerning Students Unable to Write Tests , see Western Engineering Guidelines at:
https://www.eng.uwo.ca/files/undergraduate/Instructions-for-students-unable-to-write-tests-or-exams-.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.

All required papers may be subject to submission for textual similarity review to commercial plagiarism detection software under license to the University for detection of plagiarism. All papers submitted will be included as source documents on the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between the University of Western Ontario and Turnitin.com (http://www.turnitin.com).

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

Important Considerations:
To ensure the best experience for both you and your classmates, please honour the following rules of etiquette:

- please **"ARRIVE"** to class on time
- please do not use your cell phone during the class
- Keep in mind the different cultural and linguistic backgrounds of the students in the course.
- Be courteous toward the instructor, your colleagues, and authors whose work you are discussing.

- Be respectful of the diversity of viewpoints that you will encounter in the class and in your readings. The exchange of diverse ideas and opinions is part of the scholarly environment. "Flaming" is never appropriate.
- Be professional and scholarly in activities related to this course.

Note that disruptive behaviour of any type during classes is unacceptable. Students found guilty of disturbing a class may be subject to disciplinary measures under the Code of Student Conduct.

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 Policy: Students are responsible for regularly checking their Western e-mail and notices posted on the course web site 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 Services for Students with Disabilities (SSD) at 519-661-2111 ext. 82147 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/services/

Students that are in emotional/mental distress should refer to Mental Health @ Western, http://www.uwo.ca/uwocom/mentalhealth/, for a complete list of options about how to obtain help.