Western University
Department of Mechanical & Materials Engineering

MME 4450A – Control Systems: Theory and Practice

COURSE OUTLINE 2025-2026

CALENDAR DESCRIPTION: Modern Control techniques for solving vibration and control problems associated with practical mechanical systems. The emphasis of the course is on the concepts, applications, and numerical simulations to aid Power-train dynamics, Hardware-in-the-loop (HIL) simulations and communications via Control Area Network (CAN).

COURSE INFORMATION:

Professor Samuel F. Asokanthan
Email: sasokant@uwo.ca
Office: SEB 2059A
Lectures:https://draftmyschedule.uwo.ca/login.cfm
Tutorials:
https://draftmyschedule.uwo.ca/login.cfm

CONSULTATION HOURS: By email appointment.

PREREQUISITES: MME 3350b or ECE 3330a

Unless you have either the requisites 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.

ACCREDITATION UNITS: Engineering Science = 85%, Engineering Design = 15%

TOPICS:

1. System description in State-space, simulation of time response using MATLAB and SIMULINK: Rigid-body, Spring-Mass, Electromechanical, Power-train components, Hydraulic, and Pneumatic Systems.
2. Controller and Observer design via Full state feedback; Controllability and Observability; Pole placement design; Ackermann's formula.
3. Introduction to optimal control; Linear Quadratic Regulator and Kalman Filter.
4. Pole placement and optimal control, and observer design via MATLAB.
5. Computer implementation of digital compensators; Tustin's method, direct and cascade realizations.
6. Linearization and controller design via Gain scheduling.
7. Practical case studies and implementations include Semi-active / fully-active automotive suspension systems, Inertial Stabilization and control, and other Multi-input multi-output mechanical/electro-mechanical/electro-hydraulic systems, Hardware-in-the-loop (HIL) simulations, and Communications via Control Area Network (CAN).

LEARNING OUTCOMES: On completion of the course, students will be able to:

- Formulation of model-based controllers using state-space methods (KB3,PA2) as well as computer-aided tools available within MATLAB/SIMULINK environment (ET3)
- Understand the formulation and implementation of digital controllers (PA2)
- Understand and work with practical control design problems that arise in industries (D3), as well as obtain an understanding of the use of HIL simulations and CAN bus communications. (PA3)

CONTACT HOURS: 3 lecture hours, 2 tutorial hours, half course

RECOMMENDED TEXT: G. F. Franklin, J.D. Powell and A. Emami-Naeini, *Feedback Control of Dynamic Systems,* 8th Edition, 2018, Prentice Hall, New Jersey ISBN 978-0133496598

REFERENCES: B. Friedland *Control System Design: An Introduction to State Space Methods*, 2005, Dover Publications, ISBN-13: 978-0486442785

K J Astrom and B Wittenmark *Computer-Controlled Systems: Theory and Design*, 3rd edition, 2011, Dover Publications, ISBN-13: 978-0486486130

UNITS: S.I.

EXAMINATIONS AND QUIZZES: Mid-term and Final Examination

EVALUATION:

All examinations will be **LIMITED OPEN BOOK. ie. <u>STUDENT PREPARED NOTE SUMMARY.</u>**
Mid term Exam: One single-sided sheet.
Final Exam: One two-sided sheet

Assignment 1: Tentative due date Week of 22 Sept	3.75%
Assignment 2: Tentative due date Week of 13 Oct	3.75%
Assignment 3: Tentative due date Week of 10 Nov	3.75%
Assignment 4: Tentative due date Week of 24 Nov	3.75%
Mid-term Exam (2 hours): Week of 27 Oct	20%
Group Assignment / Presentation: Weeks of 17 Nov and 24 Nov	15%

The group assignment: Practical case studies of Controller Design, simulation and Implementation for Mechanical Systems (Two students per group)

Final Examination (3 hours) During U/G examination period	50%

If a minimum of 50% is not obtained on the final examination, the student cannot receive a mark greater than 48% (However, special consideration may be given to those who participate well in the in-class and project activities)

Assignments will provide minimal (but sufficient) experience to master each aspect of the course. Marks will be deducted for late submissions of assignments.

<u>Activities in which collaboration is permitted:</u>

- Group Assignment (Project)

<u>Activities in which students must work alone (collaboration is not permitted):</u>

- Assignments, Mid-term Exam, Final Exam

Activities in which use of generative Artificial Intelligence (AI) is not permitted:

- Assignments, Mid-term Exam, Final Exam, individual topic presentation, and summary

Activities in which use of generative Artificial Intelligence (AI) is permitted:

- Group project. If used, details of its use must be acknowledged during the presentation and documented in the final report.

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 the improper use of English. Additionally, poorly written work with the exception of final examinations 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 or laboratory periods in any course, will be reported to the Dean (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Dean, the student will be debarred from taking the regular examination in the course.

CHEATING: University policy states that cheating, including plagiarism, is a scholastic offense. 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. (see Scholastic Offence Policy in the Western Academic Calendar).

ACCESSIBILITY: Students with disabilities work with Accessible Education (formerly SSD) which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The accommodation policy can be found here: Academic Accommodation for Students with Disabilities.

STATEMENT ON GENDER-BASED AND SEXUAL VIOLENCE

Western is committed to working to end gender-based and sexual violence on campus and in our community 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: https://www.uwo.ca/health/gbsv/support/get-help.html. To connect with a case manager or set up an appointment, please contact support@uwo.ca.

USE OF GENERATIVE ARTIFICIAL INTELLIGENCE (AI)

The use of generative artificial intelligence (AI) tools/software/apps is acceptable in specific situations. Students who use it must acknowledge with a specific statement on the use and on the situations when they use it. However, if it is not to be used, the instructor will indicate accordingly.

NOTE: The above topics and outline are subject to adjustments and changes as needed. Students who have failed an Engineering course (ie.<50%) 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 for grading by the student in subsequent years.