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:

The Mechanical and Materials Engineering Program has been accredited by Canadian Engineering Accreditation Board (CEAB) of Engineers Canada. Accredited programs provide the academic requirements for licensure as a professional engineer in Canada. Western Engineering has defined indicators of the 12 Graduate Attributes (GAs) that the CEAB expects graduating engineering students to demonstrate. The connections between course learning outcomes and Western Engineering's GA Indicators are identified below.

Upon completion of this 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) (***designated assessment***): 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)

Activities in which students must work alone (collaboration is not permitted):

- 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.

General Faculty / University Policies

The Faculty of Engineering and Western University have overarching policies that prescribe how undergraduate courses should run. The course-specific policies described above should be considered *in addition to* those overarching policies, or as course-specific interpretations of them. In the event of contradictions or confusion between course-specific policies above and general Faculty / University policies, please contact your course instructor for clarification.

Western Engineering's undergraduate polices can be found by navigating to:
https://www.eng.uwo.ca/undergraduate/academic-support-and-accommodations/policies.html

and then clicking the "*Engineering Undergraduate Policies framework*" link.