Western University
Department of Mechanical & Materials Engineering

MME 3350B - System Modeling and Control

COURSE OUTLINE – 2024-2025

CALENDAR DESCRIPTION: Basic analytical techniques for modeling and control of dynamic systems. Solve for response as well as design controllers to shape response of systems. Applications to vibratory, thermo-fluidic, hydraulic, pneumatic and electro-mechanical systems.

COURSE INFORMATION:

Instructor: Dr. Samuel Asokanthan
Professor
Room: SEB 2059A
Email: sasokant@uwo.ca

Lecture, tutorial and lab schedules: https://draftmyschedule.uwo.ca/login.cfm

PREREQUISITES: NMM 2270A/B or the former Applied Mathematics 2270A/B, MME 2273A/B, MME 3381A/B. 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.

ANTIREQUISITES CBE 3310A/B.

ACCREDITATION UNITS: Engineering Science = 100%

TOPICS:

1. Brief discussions of the history of automatic control systems; Application of Laplace Transformations and the Inverse Transformation;
2. Modelling of Rigid-body, Spring-Mass, Electromechanical, Thermal, Hydraulic, and Pneumatic Systems.
3. Simulation of response using MATLAB and SIMULINK
4. Transfer functions, Block-Diagram Reduction, Response of First and Second Order Systems to Impulse, Step, Ramp and Decaying Exponential Inputs. Dominant-pole design based on time-domain response.
5. Stability analysis via Routh's stability criterion; use of feedback-control design to shape system response
6. Analysis of three-term PID (Proportional+Integral+Derivative) Controllers;
7. Root Locus Method; Controller design via Root Locus; Control design tools in MATLAB
8. Bode Plot; Controller design in the Frequency-Domain; Control design tools in MATLAB

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:

1. Establish dynamic models that represent practical control problems that arise in automotive, aerospace and power-generation industries. PA 2
2. Employ the developed models to predict dynamic behavior as well as design suitable controllers to shape system response. PA 2, PA 3
3. Analyze as well as design model-based controllers using computer-aided tools available within MATLAB/SIMULINK environment and understand the implementation issues. ET 2

UNITS: S.I.

CONTACT HOURS: 3 lecture hours, 2 tutorial hours, 0.5 Lab hour, half course

TEXT: G. F. Franklin, J.D. Powell and A. Emami-Naeini, *Feedback Control of Dynamic Systems*, 8th Edition, 2019, Prentice Hall, New Jersey ISBN-13: 9780134726076. Online edition available from the publisher at a lower price.

For pricing information, refer to the publisher's website https://www.pearson.com

REFERENCES: TBA

EXAMINATIONS AND QUIZZES: Mid-term and Final Examination

EVALUATION: The final grade is computed as follows:

Individual Assignments	***10%***
Assignment 1: Due week of Jan 27 (tentative)	2.5%
Assignment 2: Due week of Feb 24 (tentative)	2.5%
Assignment 3: Due week of Mar 17 (tentative)	2.5%
Assignment 4: Due week of Mar 31 (tentative)	2.5%
Quizzes (45 mins each)	***12%***
Quiz 1: Week of Feb 3(tentative)	7.5%
Quiz 2: Week of Mar 24 (tentative)	4.5%
Laboratories (Two Labs)	***13%***
Mid-term Examinations (2 hours) (Designated Assessment)	
Week of Mar 10 (tentative)	***20%***
Final Examination (3 hours)	***45%***
Date during examination period TBA	

All examinations will be **closed-book**. **A Formula sheet will be provided (single side sheet for the mid-term and double-sided sheet for the final exam). Quizzes** will be **OPEN-BOOK/OPEN NOTES.**

If a minimum mark of 50% is not obtained on the final examination, the student cannot receive a final mark greater than 48%.

Assignments will provide minimal (but sufficient) experience to master each aspect of the course. Assignment marks will be composed of **completion (80%)** and **mark for ONE randomly selected question (20%)**. Marks will be deducted for late submissions of assignments.

CONSULTATION HOURS:

Office hours: TBA (or by appointment)

COURSE POLICIES:

<u>The following course-specific policies will be enforced throughout the course:</u>

Midterm examination

- The exam will be administered using the most appropriate modality practiced at the time.
- Only non-programmable calculators will be allowed during the midterm examination.
- The midterm is the Designated Assessment for this course. Requests for academic consideration without supporting documentation (such as a doctors note) will be denied. Students who miss the midterm without receiving academic consideration will receive a grade of 0. Students who miss the midterm with academic consideration will have the weight of the midterm shifted to the final.
- If cheating during the midterm is suspected, the Associate Chair Undergrad will investigate and will determine an appropriate resolution. This may range from completing a one-on-one oral examination with the instructor, to receiving a grade of zero on the midterm, to further academic penalties for scholastic offences applied by the Associate Dean Undergrad.
- Students are required to contact the instructor of the course for any other circumstances that appear to not be covered by the non-exhaustive list above.

Final examination

- The exam will take place during the Spring examination period. Its timing will be announced in advance.
- The exam will be Limited open book with instructor provided formula sheet.
- The exam will be administered using the most appropriate modality practiced at the time
- The length of the final exam will be three hours.
- If a minimum of 50% is not obtained on the final examination, the student cannot receive a final mark greater than 48%.
- If cheating during the final examination is suspected, the Associate Chair Undergrad will investigate and will determine an appropriate resolution. This may range from completing a one-on-one oral examination with the instructor, to receiving a grade of zero on the exam, to further academic penalties for scholastic offences applied by the Associate Dean Undergrad.
- Students are required to contact the instructor of the course for any other circumstances that appear to not be covered by the non-exhaustive list above.

Final course grade – alternative weighting scheme

- For eligible students, the contributions of the midterm and final exam to the final course grade will be automatically selected from the two options below, based on whichever is most beneficial for the student's final course grade:
    - Option 1: Midterm and final exam grades contribute to final course grade according to the distributions described in the "Evaluation" section.
    - Option 2: Midterm grade is ignored, and weight is shifted to the final exam.
- To be eligible for Option 2, students must have attempted and received a grade of at least 50% on the midterm, and received a cumulative grade of at least 50% for the Assignments, quizzes and the labs.
- Students with academic accommodations for the midterm and those who experienced severe technical difficulties during the midterm which could not be resolved after contacting the proctor or course instructor will automatically be graded according to Option 2, regardless of other course component grades.