CONTROL SYSTEMS
MECH ENG 4R03
Spring/Summer 2024 Course Outline

Department of Mechanical Engineering
McMaster University

COURSE OBJECTIVE

This course aims to introduce you to the following: (1) Derivation of mathematical models using ordinary differential equations and Laplace transforms, (2) Analysis of single input/single output systems and their components. This analysis includes a consideration of the system's time response, frequency response, and stability characteristics. (3) Design of controllers for single input single output systems that meet design requirements, using root locus and frequency response techniques.

COURSE PREREQUISITES

Prerequisite(s): Registration in Level III Mechanical Engineering; or Level IV Mechanical Engineering and Management or Mechanical Engineering and Society
Antirequisite(s): ELEC ENG 3CA3, 3CK4, 3TP3, 3TP4 REQUIRED COURSE MATERIALS AND READINGS.

INSTRUCTOR AND CONTACT INFORMATION

Instructor: Dr. Ryan Ahmed
Email: ryan.ahmed@mcmaster.ca

Office Hours: Tuesdays: 6:00-7:00 PM or by appointment

Office: McMaster Automotive Resource Center (MARC)
Center for Mechatronics and Hybrid Technologies (CMHT) –
Room 224

TEACHING ASSISTANT CONTACT INFORMATION

Ahmed Abdulmaksoud
Email: abdula96@mcmaster.ca

COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION

All Lectures will be delivered live using MS Team:
Time: Tuesdays and Thursdays, 7:00 PM – 10:00 PM
Class: Virtual via MS Teams

All lectures and course material are posted and available on Avenue to Learn
http://avenue.mcmaster.ca/MECHENG 4R03:Control Systems

LEARNING OUTCOMES

By the end of this course, students should be able to:
1. Describe control systems using accurate terminology.
2. Understand the advantages associated with a closed-loop control system.
3. Model a control system in the Laplace domain and state space representations.
4. Make reasonable assumptions to simplify a complex control system.
5. Assess the stability of a control system.
6. Assess the steady state errors associated with a particular control system.
7. Design a controller using root locus techniques.
8. Design a controller using frequency response techniques.
9. Make design recommendations that will improve system performance.

COURSE MATERIALS

Required Texts:
N. S. Nise, Control Systems Engineering, 8th Ed. Wiley, Toronto, 2019 (Earlier or later editions may also be used)
Available via the website: www.wiley.com/college/nise

Calculator: Only the McMaster Standard Calculator will be permitted in tests and examinations. This is available at the Campus Store.

Other Materials:
All students will have free access to the following:
• MATLAB and Simulink software
Information on how to download the above software is provided on Avenue to Learn.

COURSE FORMAT AND EXPECTATIONS

The course is organized as follows:
• 2 live lectures per week delivered using MS Team and accessible through Avenue to Learn.
• 1 Midterm exam.
• 1 Final exam.
• 4 In-class quizzes.
• Requirement for the completion of 2 online training modules before Tuesday, May 15th. The online modules are 2 hours each long and accessible as follows:
    - o MATLAB Onramp: https://www.mathworks.com/learn/tutorials/matlab-onramp.html
    - o Simulink Onramp: https://www.mathworks.com/learn/tutorials/simulink-onramp.html
• Students would need to register and download the Matlab/Simulink software that are freely available to McMaster students and staff. Instruction on how to register and download this software is provided on Avenue to Learn.

EVALUATION

All work will be evaluated individually except in some instances where group work is expected. In these cases, group members will share the same grade adjusted by peer evaluation. Your final grade will be calculated as follows:

Components and Weights

- Midterm Exam 25%
- Final Exam 50%
- Class Participation 5%
- Quizzes 10%
- Matlab/Simulink OnRamp 10% (5% for Matlab, 5% for Simulink)

Communication and Feedback

Students who wish to correspond with the instructor directly via email must send messages that originate from their official McMaster University email account. This protects the confidentiality and sensitivity of information as well as confirms the identity of the student.

Instructors are encouraged to conduct an informal course review with students by Week #4 to allow time for modifications in curriculum delivery. Instructors should provide evaluation feedback for at least 10% of the final grade to students prior to Week #8 in the term.

ACADEMIC DISHONESTY

It is the student's responsibility to understand what constitutes academic dishonesty. Please refer to the University Senate Academic Integrity Policy at the following URL:

http://www.mcmaster.ca/policy/Students-AcademicStudies/AcademicIntegrity.pdf

This policy describes the responsibilities, procedures, and guidelines for students and faculty should a case of academic dishonesty arise. Academic dishonesty is defined as to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. Please refer to the policy for a list of examples. The policy also provides faculty with procedures to follow in cases of academic dishonesty as well as general guidelines for penalties. For further information related to the policy, please refer to the Office of Academic Integrity at:

http://www.mcmaster.ca/academicintegrity

STUDENT ACCESSIBILITY SERVICES

Student Accessibility Services (SAS) offers various support services for students with disabilities. Students are required to inform SAS of accommodation needs for examinations on or before the last date for withdrawal from a course without failure (please refer to official university sessional dates). Students must forward a copy of such SAS accommodation to the instructor immediately upon receipt. If a student with a disability chooses NOT to take advantage of an SAS accommodation and chooses to sit for a regular exam, a petition for relief may not be filed after the examination is complete. The SAS website is:

http://sas.mcmaster.ca

POTENTIAL MODIFICATIONS TO THE COURSE

The instructor and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes.

COURSE SCHEDULE

Date/Week (Approximate)	Topic	Lectures	Readings – Book Sections
1	Course Introduction	1	All section Chapter 1
1	Laplace Transform and Transfer Functions	2	2.1 to 2.3
2 and 3	Modeling	3 to 5	2.4 to 2.8; 3.1 to 3.4
4	Reduction of Multiple Subsystems	6, 7	5.1 to 5.5
4	Linearization	8	2.10, 2.11
5	Time Response	9,10,11	4.1 to 4.9
6	Stability	12	6.1 to 6.4
7	Steady State Errors	14	7.1 to 7.2
8	PID controllers	15, 16	
9	Root Locus Techniques	17, 18	8.1 to 8.7
10	Design Via Root Locus	19	9.1 to 9.4
11	Frequency Response Techniques	20 to 23	10.1 to 10.7
12, 13	Design Via Frequency Response	24	
13	Course Review		