

Mechanical Engineering 4R03 CONTROL SYSTEMS

Undergraduate Studies
Winter 2021
Course Outline

CALENDAR/COURSE DESCRIPTION

The purpose of this course is 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.

PRE-REQUISITES AND ANTI-REQUISITES

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

INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

Dr. Saeid Habibi

JHE 410A

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Tel: (289) 6740250 ext. 59079

Office Hours:

Monday – 6:30 - 7:30 am

Tuesday – 11:30 am to 12:30 pm

Or by appointment

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

S. Akhtar

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Office Hours:

N/A

COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION

All lectures and course material are posted and available on Avenue to Learn

<http://avenue.mcmaster.ca/>

MECHENG 4R03:Control Systems

COURSE INTENDED 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 both 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; and
9. make design recommendations that will improve system performance.

MATERIALS AND FEES

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; and
- Quanser 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:

- 3 live lectures per week delivered using MS Team and accessible through Avenue to Learn.
- 3 in-class midterm tests:
 - Midterm I Thurs. Feb. 4th
 - Midterm II Thurs. Mar. 4th
 - Midterm III Thurs. Apr. 1st
- 4 in-class quizzes.
- Requirement for the completion of 2 online training modules before Monday 25th January. The online modules are 2 hours each long and accessible as follows:
 - MATLAB Onramp: <https://www.mathworks.com/learn/tutorials/matlab-onramp.html>
 - 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.

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		

ASSESSMENT

Component	Due Date	Weight
Onramp Matlab (online training)	Mon. Jan 25 th	5%
Onramp Simulink (online training)	Mon. Jan 25 th	5%
4 In-Class Quizzes		4%
Midterm I	Thurs. Feb. 4 th	12%
Midterm II	Thurs. Mar. 4 th	12%
Midterm III	Thurs. Apr. 1 st	12%
Final Exam	Scheduled by Registrar	50%
Total		100%

All MSAF'ed Midterm Grades will be Shifted to Final

ACCREDITATION LEARNING OUTCOMES

The Learning Outcomes defined in this section are measured for Accreditation purposes only and will not be directly taken into consideration in determining a student's grade in the course.

Outcomes	Indicators
Knowledge base for Engineering	1,3,4
Problem Analysis	2
Investigation	1, 2
Design	1, 2

For more information on Accreditation, please visit: <https://www.engineerscanada.ca>

EQUITY, DIVERSITY, AND INCLUSION

Every registered student belongs in this course. Diversity of backgrounds and experiences is expected and welcome. You can expect your Instructor to be respectful of this diversity in all aspects of the course, and the same is expected of you.

The Department of Mechanical Engineering is committed to creating an environment in which students of all genders, cultures, ethnicities, races, sexual orientations, abilities, and socioeconomic backgrounds have equal access to education and are welcomed and treated fairly. If you have any concerns regarding inclusion in our Department, in particular if you or one of your peers is experiencing harassment or discrimination, you are encouraged to contact the Chair, Associate Undergraduate Chair, Academic Advisor or to contact the [Equity and Inclusion Office](#).

PHYSICAL AND MENTAL HEALTH

For a list of McMaster University's resources, please refer to the [Student Wellness Centre](#).

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. **It is your responsibility to understand what constitutes academic dishonesty.**

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university. For information on the various types of academic dishonesty please refer to the [Academic Integrity Policy](https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/), located at <https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/>

The following illustrates only three forms of academic dishonesty:

1. plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
2. improper collaboration in group work.
3. copying or using unauthorized aids in tests and examinations.

COURSES WITH AN ON-LINE ELEMENT

McMaster is committed to an inclusive and respectful community. These principles and expectations extend to online activities including electronic chat groups, video calls and other learning platforms.

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor.

CONDUCT EXPECTATIONS

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the [Code of Student Rights & Responsibilities](#) (the “Code”). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online.**

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students’ access to these platforms.

ACADEMIC ACCOMMODATION OF STUDENTS WITH DISABILITIES

Students with disabilities who require academic accommodation must contact [Student Accessibility Services](#) (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University’s [Academic Accommodation of Students with Disabilities](#) policy.

COURSE POLICY ON MISSED WORK, EXTENSIONS, AND LATE PENALTIES

1. It is the students’ responsibility to regularly check the course webpage (on Avenue to Learn) for updates and announcements.
2. Download the Matlab/Simulink software as per the instructions provided on the course webpage (on Avenue to Learn).
3. Download the Quanser software as per the instructions provided on the course webpage (on Avenue to Learn)

SUBMISSION OF REQUEST FOR RELIEF FOR MISSED ACADEMIC WORK

In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar “Requests for Relief for Missed Academic Term Work”.

1. **Relief for missed academic work worth less than 25% of the final grade resulting from medical or personal situations lasting up to three calendar days:**
 - Use the [McMaster Student Absence Form](#) (MSAF) on-line self-reporting tool. No further documentation is required.
 - Students may submit requests for relief using the MSAF once per term.
 - An automated email will be sent to the course instructor, who will determine the appropriate relief. Students must immediately follow up with their instructors. Failure to do so may negate the opportunity for relief.
 - The MSAF cannot be used to meet a religious obligation or to celebrate an important religious holiday.
 - The MSAF cannot be used for academic work that has already been completed attempted.
 - An MSAF applies only to work that is due within the period for which the MSAF applies, i.e. the 3-day period that is specified in the MSAF; however, all work due in that period can be covered by one MSAF.
 - The MSAF cannot be used to apply for relief for any final examination or its equivalent. See *Petitions for Special Consideration* above.

2. For medical or personal situations lasting more than three calendar days, and/or for missed academic work worth 25% or more of the final grade, and/or for any request for relief in a term where the MSAF has been used previously in that term:
 - Students must report to their Faculty Office to discuss their situation and will be required to provide appropriate **supporting documentation**.
 - If warranted, the Faculty Office will approve the absence, and the instructor will determine appropriate relief.

ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR SPIRITUAL OBSERVANCES (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the [RISO](#) policy. Students should submit their request to their Faculty Office **normally within 10 working days** of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.