Mechanical Engineering 4R03
CONTROL SYSTEMS
Undergraduate Studies
Winter 2024
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
Anti requisite(s): ELEC ENG 3CA3, 3CK4, 3TP3, 3TP4

INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

Dr. Saeid Habibi
JHE 410A
habibi@mcmaster.ca
Tel: (289) 6740250 ext. 59079
Office Hours:
Tuesdays – 3:30 - 4:30 pm
Thursdays – 3:30 am to 4:30 pm
Or by appointment

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

O. Folorunso
S. Akhtar
O. Dorkar
A. Jha
E. Majma
Office Hours: N/A

COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION

All Lectures will be delivered on:
Tuesdays – 2:30 - 3:20 pm
Thursdays – 2:30 to 3:20 pm
Fridays – 2:30 - 3:30 pm

Room: ITB 137

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:**
(Earlier or later editions may also be used)
Available via the website: [www.wiley.com/college/nise](http://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:
- 3 live lectures per week.
- 3 Midterm tests:
  - Midterm I Jan. 30th
  - Midterm II Feb. 29th
  - Midterm III Mar. 28th
- 4 in-class quizzes.
- Requirement for the completion of 2 online training modules before 2nd February. The online modules are 2 hours each long and accessible as follows:
- 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

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

### Assessment

<table>
<thead>
<tr>
<th>Component</th>
<th>Due Date</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onramp Matlab (online training)</td>
<td>Feb. 2nd</td>
<td>5%</td>
</tr>
<tr>
<td>Onramp Simulink (online training)</td>
<td>Feb. 2nd</td>
<td>5%</td>
</tr>
<tr>
<td>4 In-Class Quizzes</td>
<td></td>
<td>4%</td>
</tr>
<tr>
<td>Midterm I</td>
<td>Jan. 30th</td>
<td>12%</td>
</tr>
<tr>
<td>Midterm II</td>
<td>Feb. 29th</td>
<td>12%</td>
</tr>
<tr>
<td>Midterm III</td>
<td>Mar. 28th</td>
<td>12%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>Scheduled by Registrar</td>
<td>50%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>100%</td>
</tr>
</tbody>
</table>

All MSAF’ed Midterm Grades will be moved 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.

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Indicators</th>
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<tbody>
<tr>
<td>Knowledge base for Engineering</td>
<td>1, 3, 4</td>
</tr>
<tr>
<td>Problem Analysis</td>
<td>2</td>
</tr>
<tr>
<td>Design</td>
<td>1, 2, 3, 4</td>
</tr>
</tbody>
</table>

For more information on Accreditation, please visit: [https://www.engineerscanada.ca](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 Engineering Physics 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.

MENTAL HEALTH & WELLNESS

For a list of McMaster University’s resources, please refer to the Student Wellness Centre. Talkspot is a non-crisis mental health resource specifically for students in the Faculty of Engineering.

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, 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.

AUTHENTICITY / PLAGIARISM DETECTION

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, other software, etc.). For more details about McMaster’s use of Turnitin.com please go to www.mcmaster.ca/academicintegrity.
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). 20% grade reduction will be applied per week for late submissions of Matlab/Simulink on-ramp certificates past the deadline.

3. All MSAF’ed Midterm Grades will be moved to Final.

4. Missed quizzes will receive zero mark.

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.