Mech Eng 4H03
Mechatronics

Undergraduate Studies
Winter 2026
Course Outline

CALENDAR/COURSE DESCRIPTION

Integration of mechanical engineering with electronics and computer control. Sensors, actuators (including pneumatic and hydraulic), modelling using building block and state space methods, model-based control, programming of PLCs with practical demonstrations.

PRE-REQUISITES AND ANTI-REQUISITES

Prerequisite: MECH ENG 4R03, SFWR ENG 3DX3 or ECE 3CL4 and registration in any Mechanical Engineering, Mechatronics Engineering, or Electrical Engineering program; or permission of the department.

INSTRUCTOR CONTACT INFORMATION

Dr. Gary Bone
gary@mcmaster.ca **(Please use your McMaster email account and include "Mech Eng 4H03" in the subject line of your email message)**

TEACHING ASSISTANT CONTACT INFORMATION

To be announced on Avenue to Learn.

COURSE WEBSITE

http://avenue.mcmaster.ca/

MATERIALS AND FEES

- Course notes will be made available on Avenue to Learn.
- Additional examples (and cool videos!) will be presented during the lectures.

COURSE FORMAT AND EXPECTATIONS

All activities will be held in-person if possible. If the activity cannot be held in-person, it will be held online using Microsoft Teams and/or Avenue to Learn. Please check Avenue to Learn regularly for announcements related to online activities, etc.. The course is organized as follows:

- Three live lectures per week (Mondays 9:30-10:20, Tuesdays 10:30-11:20, and Thursdays, 9:30-10:20).
- The only tutorial will be on PLC programming. It will be held on either Mar. 19, Mar. 23 or Mar. 24, depending on your assigned tutorial section.
- Three midterm tests. These will be 50 minutes each, replacing the lectures on the following days: Feb. 12 (test 1), Mar. 12 (test 2) and Mar. 30 (test 3).
- One final exam (2.5 hours)
- The tests and final exam will be closed-book. Only the McMaster Standard Calculator will be permitted.

COURSE INTENDED LEARNING OUTCOMES

By the end of this course, students should be able to:

1. List several types of sensors and actuators, and describe their properties.
2. Analyse a measurement system operating under static and dynamic conditions.
3. Design electro-mechanical, hydraulic and pneumatic actuators.
4. Derive mechanistic models for dynamic systems.
5. Design a model-based digital control system.
6. Design a functional PLC programs and write it using standard symbols.
7. Describe methods for improving the safety of mechatronic systems.

COURSE SCHEDULE

Topics	Readings from Course Notes
1. *INTRODUCTION*	
• What is Mechatronics?	Chapter 1
• The Role of Computer Simulations in Mechatronic Engineering	
• Examples of Mechatronic Systems	
2. *SENSORS*	
• Sensor Performance Specifications	
• Standard Industrial Sensors	Chapter 2
• Sensor Interfacing	
• Sensor Selection	
3. *ACTUATORS*	
• Mechanisms	Chapter 3
• Electrical Actuators	
• Pneumatic and Hydraulic Actuators	
4. *MATHEMATICAL MODELLING OF DYNAMIC SYSTEMS*	
• Building Block Approach	
• Introduction to the State Space Method	Chapter 4
• Discrete Time Models	
• Introduction to the System Identification Method	
5. *PROGRAMMABLE LOGIC CONTROLLERS*	Chapter 5
• Operation of PLCs	
• Ladder Logic Programming	

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6. ***DIGITAL CONTROL OF DYNAMIC SYSTEMS***
   - ON-OFF Control — Chapter 6
   - PID Control
   - Model-Based Direct Digital Design

7. ***INTRODUCTION TO DESIGNING FOR SAFETY***
   - Risk Assessment and Risk Reduction
   - System Faults and Fault Management — Chapter 7
   - Fault Detection and Fault Tolerance Techniques
   - Issues related to System Architectures, Human Factors, and Reliability

ASSESSMENT

Component	Weight
Test 1	10%
Test 2	15%
Test 3	15%
Final Exam	60%*
Total	100%

***The weight(s) of MSAF'd test(s) will be added to the weight of your final exam.**

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 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 four 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.**
4. **Sharing information when writing tests or examinations.**

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 or Microsoft Teams 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.

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. This course will use on-line elements (e.g. e-mail, Microsoft Teams, Avenue to Learn (A2L), 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.

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 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.

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

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 and course notes by University instructors**

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.

The instructor and university reserve the right to modify elements of a 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 website weekly (or more often) during the term and to note any changes.

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
1. Knowledge Base for Engineering	1.4.Competence in Specialized Engineering Knowledge
2. Problem Analysis	2.1 Demonstrates an ability to identify reasonable assumptions that could/should be made before a solution path is defined. 2.2 Demonstrate an ability to identify a range of suitable engineering fundamentals that are potentially useful for analyzing a technical problem.

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