

MECH ENG 4SS3/6SS3
Smart Systems
Undergraduate Studies
Fall 2023
Course Outline

CALENDAR/COURSE DESCRIPTION

This course will teach the fundamentals of smart systems which incorporate elements of sensing, actuation, and control in order to interact with the environment and make decisions in a predictive and intelligent manner. Students will learn how to mathematically model systems, how to program and implement Kalman filters, how to tune and code PID controllers, how to collect and process sensor data, and how to apply machine learning strategies for system optimization.

The course will be taught by means of lectures and tutorials delivered both in person and virtually (hybrid). **The University rules on academic dishonesty and originality (outlined below) will be strictly enforced.**

PRE-REQUISITES AND ANTI-REQUISITES

Prerequisite(s): MECH ENG 4R03 or IBEHS 4A03 or MECHTRON 3DX4
Antirequisite(s): None

INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

Dr. S. Andrew Gadsden
gadsden@mcmaster.ca

Office Hours:
1 hour following each lecture, JHE 307 or MS Teams

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

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COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION

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

- All course material (lecture notes, tutorials, and assignments) will be posted on A2L.
- Lectures will be delivered in person and/or virtually, and notes will be made available on A2L.
- Tutorials will be held in person with solutions/notes made available on A2L.
- Primary mode of communication and virtual lectures will be through MS Teams and/or A2L.

COURSE INTENDED LEARNING OUTCOMES

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

- Mathematically model mechanical and/or electrical systems through first-order equations and state-space representation.
- Simulate linear and nonlinear dynamic systems in MATLAB or Python.
- Explain estimation theory and derive the Kalman filter equations.
- Program, simulate, and implement the Kalman filter in MATLAB or Python.
- Explain and tune PID controllers in both a simulated environment (MATLAB or Python) and embedded

system.

- Understand how to properly collect and process data from sensors on an experimental setup.
- Understand how to apply machine learning strategies on data collected from an experimental setup for optimization purposes.
- Properly format and prepare a resume for a relevant technical job posting found in industry.

MATERIALS AND FEES

Required Texts: None

Other References:

- Control Systems Engineering, 8th Edition, Nise, Wiley, 2019.
- Kalman Filtering: Theory and Practice with MATLAB, 4th Edition, Grewal and Andrews, Wiley, 2014.
- Probabilistic Machine Learning: An Introduction, Murphy, MIT Press, 2022.
- MATLAB website: <https://www.mathworks.com/>

Calculator:

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

Other Materials:

MATLAB programming is a mandatory component in this class. Students must obtain a valid program and license for MATLAB prior to the first tutorial. Python is an open-source program very similar to MATLAB and can be used as well.

COURSE FORMAT AND EXPECTATIONS

The course is organized as follows:

- 2 x 50-min lectures per week
 - Monday's on Avenue to Learn or MS Teams (pre-recorded lectures or virtually)
 - Wednesday's at 11:30 am in ABC XYZ (in-person)
 - Check A2L or Mosaic for room location
- 1 x 50-min lecture given as tutorial per week in-person
 - Friday's at 1:30 pm in ABC XYZ
 - Check A2L or Mosaic for room location
- 5 assignments based on lecture content (total 35%)
- 1 resume workshop assignment (5%)
- 1 in-class midterm based on all course content (20%)
- 1 course project (40%)
- Note for 6SS3 students: an additional course project (to be discussed at the start of the term) will be required and assessed at 20%. In this case, the 4SS3 course project will be assessed at 20%.

COURSE SCHEDULE (TENTATIVE)

Posted on Avenue to Learn.

ASSESSMENT

Component	Weight
Assignments (individual)	35%
Resume Workshop and Assignment (individual)	5%
Midterm (individual)	20%
Final Project (group)	40%
Total	100%

Note for 6SS3 students: the Final Project will be assessed at 20%. Another course project linking smart systems to the student's graduate thesis/project will be provided and assessed at 20%. This additional project will be discussed individually at the start of the semester.

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
Solve differential equations to model linear and nonlinear dynamic systems.	1.1
Apply estimation and control strategies in a simulated environment.	5.2
Develop and apply advanced 'smart system' techniques on an experimental setup.	5.2
Prepare a resume for career advancement	7.2

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 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](#).

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.

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.

ONLINE PROCTORING

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

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 (ex. Avenue to Learn) for updates and announcements.
2. Assignment submissions overdue by less than 48 hours from the deadline will be marked out of 50%. The dropbox on A2L will not accept assignment submissions later than 2 days.
3. The weight of all MSAF’d assignments and/or midterm exams will be transferred to the 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 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.