Carleton University
Department of Mechanical and Aerospace Engineering
MECH 4806: Mechatronics - Fall 2021

Course Offering: ONLINE SYNCHRONOUS
Use the following Zoom link for all lectures (unless the link is later changed by the instructor):
https://carleton-ca.zoom.us/j/91279500555
Meeting ID: 912 7950 0555
Passcode: MECH-4806
Topic: MECH4806 Mechatronics, WF 1:00pm-2:30pm.

Instructor: Prof. M. Ahmadi (mojtaba.ahmadi@carleton.ca)
Prerequisite: Feedback Control - MAAE 4500 or SYSC 4505

Learning Objectives: This course will make you familiar with the fundamentals of mechatronics including the following learning objectives:

1. You will learn how using a computer to control a real system will affect the control problem and how basic controllers can be implemented using digital computers.
2. You will learn about signals are sampled and select proper sampling rates for process control.
3. You will learn about the fundamentals of semiconductor electronics and how to design basic circuits using diodes, transistors, and amplifiers. You will also be able to build prototypes of your designed circuits to meet certain requirements.
4. You will learn how to design basic combinatorial and sequential logic circuits that are used in almost every digital device today.
5. You will learn the fundamentals of microcontrollers and practice interfacing physical systems through a practical project.
6. You will learn about electrical sensors and actuators and how to process sensor information.
7. You will learn how to design, plan, and integrate a complete mechatronic system through your project execution in collaboration with your team members.
8. If time permits, you will learn how to use computer software to simulate various elements of mechatronic systems.

Textbook: "Introduction to Mechatronics and Measurement Systems" by D. Alciatore and M. Histand, 4th (2012) or 5th editions from McGraw Hill may be fine.   I do not order the books, but the bookstore can place an order for you to be received within a few days. You may also find the book in other ways as you wish. The book only covers about 70% of the material, the rest are based on class discussions and summary notes provided by the instructor. However, extensive material are available on the internet. Attending the lectures is essential in succeeding in this course.

Other supplies for the course: The instructor will introduce a mechatronics Kit to be purchases by the students for some remote practical experiments while the course is still online, and the pandemic situation persists. The cost of such kits would vary between $60 to $120. The desired kit will be announced after the first two-three weeks of the course when all the student groups are formed.

Topics covered:
Introduction to mechatronic systems and design
−   Introduction to mechatronic devices and systems
−   Identification of the main components of mechatronic systems and examples
Computer control and sampling effects

- Introduction to sampling
- Fundamentals of computer-controlled systems: discrete-time systems
- Stability of computer-controlled systems
- Signal analysis

<u>Fundamentals of Analog Electronics and Semiconductors</u>
- Basic circuits components
- Basic semiconductor electronic components and circuits
- Analog signals and processing: Amplifiers and their applications

<u>Fundamentals of Digital Electronics</u>
- Combinational logic circuits
- Sequential logic circuits
- Applications

<u>Microprocessor-based control</u>:
- Real-time systems and requirements
- Micro-controllers
- Data acquisition and virtual instrumentation

<u>Sensors and Actuators</u>
- Basics of measurement and data acquisition
- Sensing systems: introduction to various sensing technologies and applications
- Actuation systems: introduction to electric machines or other actuation systems and drives

<u>Case Studies</u>
- Mechatronic systems application cases: Robotics, Biomechatronics, etc.
- Student project presentations
- Intelligent and industrial control systems (if time permits)

Lectures: 3 hours/week. Note that a number of guest speakers may present topics as related to the course or provide hands-on workshops. The contents of these talks, presentations, or demonstrations are considered an integral part of the course material and evaluation.

Communication: Classroom announcements and CuLearn.

Evaluation:

Term Activities (quizzes, project, group assignments)	50%
Final exam (format, content, and date TBA)	50%

	100%

Exams will test you on the lecture material as well as your skills gained through the lab and project work. The term activities may involves some quizzes and some theoretical, practical, or simulation exercises that will be announced one by one. This is a special year and there is no direct access to lab spaces (as of yet). We will try to optimize the experiential learning components of this course through electronic kits, etc where you can do special projects.

Notes about projects and activities: Since our real lab activities are very limited during Pandemics, we will be designing special projects or may give students options as the term progresses. I may suggest a mechatronics/microcontroller kit that you would be able to conduct limited experiments while being remote.

1. Make small groups (ideally 3 students) should be formed by the end of the 4th lecture.
2. Group assignments, labs, and the project are assigned to the same group.

3. Students should plan to be available during a 2-hour period for any lab or project preparation activity in some of the weeks as needed by this course.
4. The details of the project requirements and potential topics will be provided in a separate document. However, students can propose their own projects upon the approval of the instructor. Projects can be design work only or practical (practical is favoured and recommended). **Up to 5% bonus** can be obtained by practical projects that go beyond the scope of a course project (that are of great quality or show a great volume of work).
5. Projects should use a microcontroller to control a system. Arduino microcontrollers are the most common. Your project should involve sensing, actuation, I/O, and control. It should also serve a meaningful purpose. The more challenging and more extensive and more successful in achieving the goals of the project, the higher the bonus mark will be, but your written report plays an important role in your evaluation.
6. The topics must be finalized by the 6th lecture, when you will be handing in a short proposal. You are welcome to see me before writing your proposal to discuss potential projects. I provide a suggested list as well. You can get an idea about some of the past projects by searching on the net or youtube with keywords including MECH 4806, Carleton, and Mechatronics. Posting a youtube video of your project is part of the project requirements.
7. The lab assignments (group activities done by the same project teams) have been mandatory and usually done in the electronics lab. We will organize some activities depending on the pandemic situation and lab availability, or design them to be done remotely using your kit.
8. The regular individual assignments are to be done by each student, but they are not going to be marked. Solutions will be provided closer to the exam time.
9. When working with electronic components, students are to be vigilant, work on an appropriate work bench and follow the main electrical safety precautions.
10. If working in a lab at school, clean up before leaving the lab. If the lab supervisor allows you to stay after regular hours, you have the make sure the door will be locked after you leave.
11. You can purchase electrical components for any project using online electronic stores such as Active Electronics, or stores such as Gervais Electronics on Industrial Road, or major kits from Amazon. Major electronic suppliers such as DigiKey can also be used.

TA information: Will be announced on the website.

Accommodation Statement
The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your *Letter of Accommodation* at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (*if applicable*). **Requests made within two weeks will be reviewed on a case-by-case basis.** After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website (www.carleton.ca/pmc) for the deadline to request accommodations for the formally-scheduled exam (*if applicable*).