



ENGG*3490 Introduction to Mechatronic Systems

Design

01

Winter 2023

Section(s): C01

School of Engineering

Credit Weight: 0.75

Version 2.00 - January 24, 2023

1 Course Details

1.1 Calendar Description

This course covers the design of mechatronic systems, which are synergistic, combinations of components and controls drawn from mechanical engineering, electronics, and computer engineering. The course covers the following areas: (1) modeling of mechatronic systems (mechanical, electrical/electronic systems) and understanding their behaviour, (2) sensing and measurement including a variety of mechatronics sensors (fundamentals and applications), (3) actuators specific to mechatronics including motors and drivers (fundamentals and applications), (4) basic microcontroller programming as well as sensor/actuator integrations, and (5) control and its applications in mechatronics.

Pre-Requisites: ENGG*2340, ENGG*2450

Co-Requisites: ENGG*3410

1.2 Course Description

This course covers an introduction to mechatronics systems. Mechatronics, in general, is involved with mechanical, electrical and computer systems. Recently, mechatronics have found a variety of applications in many fields especially in the automation and manufacturing industries. In this course, you will learn about mechatronics systems: how are they designed and controlled. We will cover programmable logic controller (PLC), review and modeling of mechatronic systems, sensing and measurement, sensors and applications, actuators and their applications, modeling and control of electric motors (dc and ac), as well as stepper and servo motors. You will learn important concepts such as analog/digital or digital/analog conversion. Microprocessors and microcontroller structures will be introduced and discussed. As well, some control techniques for mechatronic systems will be introduced, and finally mobile robotic systems and their recent advances will be reviewed. By the end of the

term, you should have a good understanding of design, modeling and control of mechatronic systems. This course contains theory and practical applications of those systems. More importantly, the course has hands-on labs which provide you with great skill sets required to succeed in your career. This course covers the following topics:

1. Introduction to mechatronic systems: basics
2. Sensors and instrumentation
3. Modeling of Mechatronics systems
4. Response
5. Actuators and Motors
6. Microprocessor and microcontroller
7. Programmable logic controller (PLC)
8. Control

1.3 Timetable

Lectures

Monday: 5:30 pm–6:50 pm, MACS 121, Room 121

Wednesday: 5:30 pm-6:50 pm, MACS 121, Room 121

Laboratory:

Monday: 11:30 AM -1:20 PM, THRN, Room 2307

Friday: 08:30 AM - 10:20 AM, THRN Room 2307

* The TA will conduct all the labs. Once the grouping is done and you receive your equipment, you will perform the labs at home. The TA will provide all the necessary instructions and arrange with the students for grouping and equipment pick up the first week of classes. This information will be posted on the Courselink. For all the lab related materials, equipment, reports, etc. please contact the TA.

Note: Labs start the week of January 15

1.4 Final Exam

Final Exam: 30%

25 April 2023, 8:30 AM - 10:30 AM

2 Instructional Support

2.1 Instructional Support Team

Instructor: Mohammad Al Janaideh Ph.D.
Email: maljanai@uoguelph.ca
Telephone: 519-824-4120
Office: THRN 1505
Office Hours: Monday 1:00-2:00 pm

Wednesday 4:00-5:00 pm

Lab Technician: Kevin Dong , P.Eng.
Email: kdong@uoguelph.ca
Telephone: 519-824-4120 x53729
Office: RICH 2506
Office Hours: By Appointment

2.2 Teaching Assistants

Teaching Assistant (GTA): Peter Sharpe
Email: sharpep@uoguelph.ca
Office Hours: TBA on CourseLink or By Appointment

3 Learning Resources

3.1 Required Resources

Course Website (Website)

News, homeworks, announcements, and grades will be regularly posted to the ENGG*3490 CourseLink site. Students are responsible for checking the site very regularly.

Required Resources (Other)

Students are expected to attend all the lectures. Students are responsible for whatever material is taught in the class. Note that the textbook may not have all the material taught in the class.

There is no single textbook that can cover all the material taught in a Mechatronics course in general, simply because Mechatronics is multidisciplinary. The following book is a great source:

“Mechatronics: A Multidisciplinary Approach”, W. Bolton, 6th edition, Prentice Hall, 2015.

3.2 Recommended Resources

Recommended Resources (Textbook)

- "Introduction to Mechatronics - Measurement Systems," David Alciatore, 2018.
- "Modeling and Analysis of Dynamic Systems," Charles M. Close, Dean K. Frederick, 2001.
- "The Design of High-Performance Mechatronics," 3rd edition R. Schmidt, G. Schitter, A. Rankers, J. Van Eijk, IOP, 2020.
- "Applied Mechatronics", A. Smaili, F Mrad, Oxford University Press, 2008.
- "Programmable Logic Controllers", Frank D. Petruzella, 3/E, McGrawHill, 2005.
- "Mechatronics", Dan S. Neculescu, Prentice Hall, 2002.
- "Principles of Robot Motion", H. Choset, K. M. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki and S. Thrun, MIT Press, Boston, 2005.
- "Electric Machinery Fundamental", by S. J. Chapman, McGraw-Hill, 5th edition, 2011.
- "Principles and Applications of Electrical Engineering", by G. Rizzoni, McGraw-Hill, 5th edition, 2007. "Electric Machinery Fundamental", by S. J. Chapman, McGraw-Hill, 5th edition, 2011.
- "Programmable Logic Controller", J. R. Hackworth, F. D. Hackworth, Jr., 4th edition, Prentice Hall, 2004.

3.3 Additional Resources

Additional Resources (Other)

Lecture Information: Students should attend the online classes and make their own notes. The lecture notes will be posted on the Courselink after each class.

Lab Information: The handouts for all the lab sessions will be posted in the lab section in the Courselink. All types of resources and links to web pages can be found in this section.

Homework: Homeworks with solutions will be posted on the Courselink.

Miscellaneous Information: Other information related to Mechatronics are also posted on the web page.

4 Learning Outcomes

4.1 Course Learning Outcomes

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

1. Learn how to work with sensors; learn how to acquire data; learn how to calibrate sensors.
2. Learn how to work with actuators and micro-controllers; learn to connect sensors and actuators to micro-controllers; learn to program micro-controllers.
3. Learn how to integrate mechatronics components
4. Learn how to design, solve problems, and perform data analysis for mechatronics systems.
5. Learn reporting and engineering communication.

4.2 Engineers Canada - Graduate Attributes (2018)

Successfully completing this course will contribute to the following:

#	Outcome	Learning Outcome
1	Knowledge Base	1
1.2	Recall, describe and apply fundamental principles and concepts in natural science	1
2	Problem Analysis	1, 2, 3, 4
2.2	Identify, organize and justify appropriate information, including assumptions	3
2.3	Construct a conceptual framework and select an appropriate solution approach	3
2.4	Execute an engineering solution	4
2.5	Critique and appraise solution approach and results	1, 2
3	Investigation	1
3.2	Design and apply an experimental plan/investigative approach (for example, to characterize, test or troubleshoot a system)	1
3.3	Analyze and interpret experimental data	1
4	Design	3
4.1	Describe design process used to develop design solution	3
7	Communication Skills	5
7.1	Identify key message(s) and intended audience in verbal or written communication as both sender and receiver	5

5 Teaching and Learning Activities

5.1 Lecture

Topics:	Background and Review
Topics:	Electrical/Electronic Systems & Modeling with Applications
References:	Class lectures
Topics:	Mechanical Systems Modeling
References:	Class lectures
Topics:	System response
References:	Class lectures
Topics:	Principles of sensing
References:	Class lectures
Topics:	Sensors
References:	Class lectures
Topics:	Actuators and Motors
References:	Class lectures
Topics:	PLC
References:	Class lectures
Topics:	Control concepts
References:	Class lectures
Topics:	Control design: state space
References:	Class lectures

5.2 Other Important Dates

Monday, January 10: Classes commence

ENGG4480 first lecture on Monday Jan 9. In person, THRN 1319

Lectures: Monday -Wednesday 5:30 - 6:50 PM, MACS 121

Friday, March 10 40th class day.

Thursday, April 6: Last day of classes.

Friday, April 7: Holiday -- No Classes Scheduled -- classes rescheduled to Monday, April 10

Monday, April 10: Classes rescheduled from Friday, April 7. Friday schedule in effect, Classes conclude

6 Assessments

6.1 Marking Schemes & Distributions

Name	Scheme A (%)
Labs and Projects	40
Midterm	15
Final Exam	35
Assignment	10
Total	100

6.2 Assessment Details

Labs and Projects (40%)

- **Lab 01:** Familiarization with Basic Laboratory Equipment (5%).
- **Lab 02:** Matlab/Simulink and Simulation of Mechatronic Systems (5%).
- **Project 01 & Lab 03:** Operational Amplifiers and their Applications (10%).
- **Project 02 & Lab 04:** Introduction to Arduino and Applications (10%).
- **Project 03 & Lab 05:** Modeling and Controller Design for Mechatronics System (Simulation using MATLAB/Simulink) (10%).

Midterm (15%)

Date: Wed, Mar 1, 5:30 PM - 6:30 PM

Learning Outcome: 4

Assignment (10%)

Assignment 01: Due 27 January 2023

Assignment 02: Due 17 February 2023

Assignment 03: Due 22 March 2023

Final Exam (35%)

Date: Tue, Apr 25, 8:30 AM - 10:30 AM

Learning Outcome: 4

25 April 2023, 8:30 AM - 10:30 AM.

detailed instructions will be given in the semester before the exam. Please also check WebAdvisor.

6.3 Important Note

While you are encouraged to discuss with other classmates about the labs, there is zero tolerance for plagiarism or copying. Cases of academic misconduct will be reported.

While the university's current plan is to return to previously scheduled F2F activities on Jan 24, it is difficult to predict the potential impacts of Covid/Omicron, remote learning, Instructor will accommodate various situations if they arise, including pivot to online assessments, changing the course project/labs, if necessary.

6.4 Final Project

Final Design Report

The purpose of this report is to communicate the progress leading up to your group's resulting design. It will detail your design specifications, explaining calculations and analyses that ensure that your final design meets specifications. It should also include all microcontroller program code and a description of the logic you used to navigate your robot. Any further testing, simulation, and results should be detailed and discussed. In addition, this report will also include changes to budgetary and scheduling plans. While the report should be comprehensive and include all the necessary information, it should not exceed **10 pages**. Appendices and codes are not counted toward the 10 page limit. Both hard and soft copies are required for submission. Reports should be submitted to the TA and are due by 5:30 pm on April 4th. Reports that are not submitted by 5:30 pm on April 4th will not receive any marks.

7 Course Statements

7.1 Relationships with other Courses & Labs

Previous Courses:

ENGG*2340: Systems, first-order, 2nd order systems, signals

ENGG*3450: Fundamentals of DC and AC circuits, KVL, KCL

Courses:

ENGG*3410: Control systems, feedback, etc.

Follow-on Courses:

ENGG*4480: Advanced Mechatronics

ENGG*4030: Manufacturing System Design

ENGG*4480: Advanced Mechatronic Systems Design

8 School of Engineering Statements

8.1 Instructor's Role and Responsibility to Students

The instructor's role is to develop and deliver course material in ways that facilitate learning for a variety of students. Selected lecture notes will be made available to students on Courselink but these are not intended to be stand-alone course notes. Some written lecture notes will be presented only in class. During lectures, the instructor will expand and explain the content of notes and provide example problems that supplement posted notes.

Scheduled classes will be the principal venue to provide information and feedback for tests and labs.

8.2 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and lab sessions. Students, especially those having difficulty with the course content, should also make use of other resources recommended by the instructor. Students who do (or may) fall behind due to illness, work, or extra-curricular activities are advised to keep the instructor informed. This will allow the instructor to recommend extra resources in a timely manner and/or provide consideration if appropriate.

8.3 Lab Safety

Safety is critically important to the School and is the responsibility of all members of the School: faculty, staff and students. As a student in a lab course you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are working in. In addition, you are responsible for reporting all safety issues to the laboratory supervisor, GTA or faculty responsible.

9 University Statements

9.1 Email Communication

As per university regulations, all students are required to check their e-mail account regularly: e-mail is the official route of communication between the University and its students.

9.2 When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. The grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Academic Consideration and Appeals

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

Graduate Calendar - Grounds for Academic Consideration

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

Associate Diploma Calendar - Academic Consideration, Appeals and Petitions

<https://www.uoguelph.ca/registrar/calendars/diploma/current/index.shtml>

9.3 Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic Calendars.

Undergraduate Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml>

Graduate Calendar - Registration Changes

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml>

Associate Diploma Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.shtml>

9.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

9.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is

required; however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to make a booking at least 14 days in advance, and no later than November 1 (fall), March 1 (winter) or July 1 (summer). Similarly, new or changed accommodations for online quizzes, tests and exams must be approved at least a week ahead of time.

For Guelph students, information can be found on the SAS website
<https://www.uoguelph.ca/sas>

For Ridgetown students, information can be found on the Ridgetown SAS website
<https://www.ridgetownc.com/services/accessibilityservices.cfm>

9.6 Academic Integrity

The University of Guelph is committed to upholding the highest standards of academic integrity, and it is the responsibility of all members of the University community—faculty, staff, and students—to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff, and students have the responsibility of supporting an environment that encourages academic integrity. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

Undergraduate Calendar - Academic Misconduct
<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml>

Graduate Calendar - Academic Misconduct
<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

9.7 Recording of Materials

Presentations that are made in relation to course work - including lectures - cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

9.8 Resources

The Academic Calendars are the source of information about the University of Guelph's procedures, policies, and regulations that apply to undergraduate, graduate, and diploma programs.

Academic Calendars
<https://www.uoguelph.ca/academics/calendars>

9.9 Disclaimer

Please note that the ongoing COVID-19 pandemic may necessitate a revision of the format of course offerings, changes in classroom protocols, and academic schedules. Any such changes will be announced via CourseLink and/or class email.

This includes on-campus scheduling during the semester, mid-terms and final examination schedules. All University-wide decisions will be posted on the COVID-19 website (<https://news.uoguelph.ca/2019-novel-coronavirus-information/>) and circulated by email.

9.10 Illness

Medical notes will not normally be required for singular instances of academic consideration, although students may be required to provide supporting documentation for multiple missed assessments or when involving a large part of a course (e.g.. final exam or major assignment).

9.11 Covid-19 Safety Protocols

For information on current safety protocols, follow these links:

- <https://news.uoguelph.ca/return-to-campus/how-u-of-g-is-preparing-for-your-safe-return/>
- <https://news.uoguelph.ca/return-to-campus/spaces/#ClassroomSpaces>

Please note, these guidelines may be updated as required in response to evolving University, Public Health or government directives.
