Carleton University
Department of Electronics
ECOR1044: Mechatronics – Fall 2021
Course Outline

Instructor Information and Office hours

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Calendar Information

ECOR1044
Mechatronics

Mechatronics applications. Boolean Algebra and Analog to digital signal conversion. Control systems and PID controllers. Input devices, including sensors and GPS. Data collection and processing. Output devices, including displays, actuators, and motors. Project design and economics. Environmental Impact of mechatronics engineering. System failures and failsafe design. Signal amplification and Op-Amps.

Precludes additional credit for ECOR 1052.

Prerequisite(s): ECOR 1041 with a minimum grade of C- and ECOR 1043 with a minimum grade of C-. This course may not be taken concurrently with ESLA 1300 or ESLA 1500.

Students who have not satisfied the prerequisites for this course must either withdraw from the course or obtain a prerequisite waiver by visiting the Engineering Undergraduate Academic Support Office.

Course Objectives

This course will introduce students to various engineering subjects such as:

- An introduction to electrical system design
- Familiarization with electrical hardware such as sensors, stepper motors and DC motors
- An introduction to analog to digital signal conversion, control systems and PID controllers
- Design aspects such as safety, performance, cost and environmental impacts
- Electrical engineering hardware
- Electrical specifications
- Engineering documentation and technical writing
- Project economics
- Cooperative group work

Learning Outcomes

By the end of this course, students should:

1) Familiarize themselves with electrical hardware such as sensors, stepper motors and DC motors
2) Understand analog to digital signal conversion, control systems and PID controllers
3) Understand and be able to apply the engineering design process
4) Be introduced to group project dynamics and learn group management techniques
5) Gain experience providing oral presentations

Graduate Attributes (GA's)

The Canadian Engineering Accreditation Board requires graduates of undergraduate engineering programs to possess 12 attributes.[1] Courses in all four years of our programs evaluate students' progress towards acquiring these attributes. Aggregate data (typically, the data collected in all sections of a course during an academic year) is used for accreditation purposes and to guide improvements to our programs. Some of the assessments used to measure GAs may also contribute to final grades; however, the GA measurements for individual students are not used to determine the student's year-to-year progression through the program or eligibility to graduate.

[1] Criterion 3.1, *2018 Accreditation Criteria and Procedures*, Canadian Engineering Accreditation Board, November 2018.

[2] The instructional level of course content related to graduate attributes is classified by the content-level codes I (Introduced), D (Developed) and A (Applied). These codes are defined in A Guide to Outcomes-Based Criteria , Version 1.25, Canadian Engineering Accreditation Board, 1 March 2015.

This table lists the GAs that will be measured in this course, along with the learning outcomes that are intended to develop abilities related to these attributes.

Graduate Attributes	**Instructional Level[2]**	**Learning outcomes (listed in the previous section)**
1.3 - Fundamental engineering concepts	I	1-5
2.1 - Problem Definition	I	2
2.2 - Approach to the problem	I	2
6.1 - Personal and group time management	I	3 & 4
6.2 - Group culture, group dynamics	I	3 & 4
6.3 - Leadership: initiative and mentoring, areas of expertise, and interdisciplinary teams	I	3 & 4
11.5 - Project definition and management techniques	I	2 - 4

Reference Material

Lecture Notes: Lectures notes will be provided which will be sufficient for this course.

Required Software

In order to perform the labs you will be required to remotely connect to the lab PCs, to do so you will need the Carleton VPN installed, instructions can be found here. You will also need to use your respective platforms remote access application, for Windows this is 'Remote Desktop Connection'. Additionally, instructions on setup and use will be posted on the course page.

Evaluation and Grading Scheme

The overall grade will be calculated as follows:

Component	Weight
Progress Reports	15%
Group Project	20%
Team Evaluation	10%
Lab Checkout	5%
Final Exam	50%

Students who fail the final exam (Achieve a grade of less than 50% on the final exam) will receive a course grade of F, regardless of their marks in the other components. For students who pass the final exam, a numeric mark out of 100 will be calculated by weighting the course components as shown above.

Final grades are not rounded, the table below describes the numerical grade ranges for each letter grade (Received final grade represented by X):

Letter Grade	Numerical Grade Range
F	$X < 50$
D-	$50 \leq X < 53$
D	$53 \leq X < 57$
D+	$57 \leq X < 60$
C-	$60 \leq X < 63$
C	$63 \leq X < 67$
C+	$67 \leq X < 70$
B-	$70 \leq X < 73$
B	$73 \leq X < 77$
B+	$77 \leq X < 80$
A-	$80 \leq X < 85$
A	$85 \leq X < 90$
A+	$90 \leq X$

Breakdown of course requirements

Progress Report 1 - The first progress report will evaluate group progress utilizing the Raspberry Pi.

Progress Report 2 - The second progress report will evaluate the students understanding of various input and output devices as they pertain to the Raspberry Pi.

Progress Report 3 - The third progress report will evaluate the students understanding of various input and output devices as they pertain to building a simple system using the Raspberry Pi.

Group Project - The group project will evaluate students total progress throughout the project.

Team Evaluation - Every group member will evaluate their teammates based on a number of factors.

Lab Checkout – Students are required to checkout at the end of each lab session and will be graded according to the quality of their work.

Final Exam - The final exam will evaluate student understanding of all course concepts.

The final examination is for evaluation purposes only and will not be returned to students. You will be able to make arrangements with the instructor or with the department office to see your marked final examination after the final grades have been made available.

To pass the course students must achieve satisfactory performance during the term. Satisfactory performance during the term is completion of the lab experiments with a combined average grade of >40% on all term work (All grades excluding the final exam).

General Regulations

Online Requirements:

Due to content currently being provided in an online capacity, **students are required** to have a stable and reliable internet connection. It will not be possible to accommodate missed labs, or other deliverables due to a dropped internet connection. To reduce the chances of this impacting you it is recommended students use a wired internet connection where possible.

Copyright on Course Materials: The materials created for this course (including the course outline and any slides, notes, program source code, labs, projects, assignments, quizzes, exams and solutions) are intended for personal use and may not be reproduced or redistributed or posted on any website without prior written permission from the author(s).

Attendance: Students are expected to attend all lectures and lab periods virtually. The University requires students to have a conflict-free timetable. For more information, see the current *Undergraduate Calendar, Academic Regulations of the University, Section 1.2, Course Selection and Registration and Section 1.5, Deregistration.*

Health and Safety: Every student should have a copy of our Health and Safety Manual. A PDF copy of this manual is available online: http://sce.carleton.ca/courses/health-and-safety.pdf

Deferred Term Work : Students who claim illness, injury or other extraordinary circumstances beyond their control as a reason for missed term work are held responsible for immediately

informing the instructor concerned and for making alternate arrangements with the instructor and in all cases this must occur no later than three (3.0) working days after the term work was due. The alternate arrangement must be made before the last day of classes in the term as published in the academic schedule. For more information, see the current *Undergraduate Calendar, Academic Regulations of the University, Section 2.6, Deferred Term Work.* Since students are required to have a stable and reliable internet connection, a **poor internet connection will not be considered a sufficient reason to defer an online exam.**

Appeal of Grades : The processes for dealing with questions or concerns regarding grades assigned during the term and final grades is described in the *Undergraduate Calendar, Academic Regulations of the University, Section 2.7, Informal Appeal of Grade and Section 2.8, Formal Appeal of Grade.*

Academic Integrity: Students should be aware of their obligations with regards to academic integrity. Please review the information about academic integrity at: https://carleton.ca/registrar/academic-integrity/. This site also contains a link to the complete Academic Integrity Policy that was approved by the University's Senate.

Plagiarism: Plagiarism (copying and handing in for credit someone else's work) is a serious instructional offense that will not be tolerated.

Academic Accommodation: You may need special arrangements to meet your academic obligations during the term. You can visit the Equity Services website to view the policies and to obtain more detailed information on academic accommodation at http://www.carleton.ca/equity/ For an accommodation request, the processes are as follows:

- **Pregnancy or Religious obligation**: Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details see https://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf
- **Academic Accommodations for Students with Disabilities**: 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*).

- **Survivors of Sexual Violence:** As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit: https://carleton.ca/sexual-violence-support/.
- **Accommodation for Student Activities:** Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, see https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf

Week-by-Week breakdown

Following is a breakdown of the topics that will be covered each week. There may be a slight variation in their order to adjust for any unforeseen circumstances.

Week	Topics	Description
1	Introduction to mechatronics, applications, hardware and software in mechatronics systems. Introduction to Binary and Digital Logic	Hardware versus software in mechatronics systems. Appropriate programming languages for mechatronics. Appropriate hardware and software platforms for mechatronic systems. Introduction to the Raspberry Pi and Python.
2	Digital Logic and Analog to Digital conversion	Continued look at digital logic, and basics of digital signals, analog to digital signal conversion.
3	Input and Output devices, interfacing, and data processing. Introduction to control systems	Mechatronics system inputs and outputs. Interfacing sensors and actuators with the Raspberry Pi. Data processing. Introduction to control systems, and project application.

Week	Topics	Description
4	Project management, and economics. Design report configuration, environmental implications, product life cycle. Failure analysis.	Project management and design processes, project economics, digital communications, Python in an embedded system. Design report methodology, environmental implications of mechatronics design, product life cycle. Fail-safe design practices, and failure analysis.
5	Failure analysis and fail-safe design case study. Personal and industry applications of mechatronics.	Analysis of industry failure and changes. Possible future projects for both personal and professional use.
6	Introduction to signal amplification and Operational Amplifiers GPS and INS Introduction	Discussion of signal amplification and introduction to Operational Amplifiers and their applications. Overview of GPS and INS functionality and their integration.