Carleton University Department of Electronics

Summer 2026

ELEC1032: Circuits and Mechatronics

Introduction

This course covers the fundamentals of electrical circuits, digital systems, and sensors and actuators. We can only skim the surface of many topics, but we hope to introduce some foundational principles and give you insight into what is involved in designing and implementing a mechatronic system. Along the way you'll encounter essential analog and digital circuit components and analysis techniques. You will be shown how to approach a group engineering design project, and will leverage knowledge of Python programming from ECOR 1031 to create a project solution.

Course Description and Requirements

Course Description: Electrical circuit fundamentals: resistance, capacitance, inductance, voltage and current sources, Ohm's law, nodal analysis, mesh analysis, source transformation, superposition. Components for mechatronics: filters, operational amplifiers, digital logic gates and combinatorial circuits, analog to digital converters, sensors, actuators, simple control schemes. Project in microcontroller-embedded mechatronic system
Includes: Experiential learning activity
Precludes: additional credit for ECOR 1043, ECOR 1044, and ECOR 1052.
Prerequisite(s): : this course may not be taken concurrently with ESLA 1300 or ESLA 1500.
Lectures: : Six hours per week
Laboratory: : Six hours per week.

Instructor

Professor: Dr. Michel Sayde
Email: michel.sayde@carleton.ca
Course Webpage: on Brightspace

Textbook: Please include price of required books

Some lecture notes will be provided but are unlikely to provide a comprehensive resource unless you attend class and reinforce or fill-in concepts. There are plenty of online resources available for this material, however quality will vary widely, use at your own risk! We are providing suggested references which may not map directly onto course material but can provide additional background.

References

DC Electrical Circuit Analysis: A Practical Approach - Open Textbook Library
AC Electrical Circuit Analysis: A Practical Approach - Open Textbook Library

Required software

KiCad (KiCad - Schematic Capture & PCB Design Software) - installed on Department computers.

Lecture Outline

In person Lectures: Tue/Thu 16:05 - 18:55, Mackenzie Building 3380

The following topics will be covered during the course lectures with an approximate schedule:
Week 0 (R, 2 Jul): (orientation week): Introduction
Week 1 – 1 (T, 7 Jul): Ohm's law, KVL, KCL, Single-loop and
Week 1 – 2 (R, 9 Jul): single-node circuits, multi-node Analysis
Week 2 – 1 (T, 14 Jul): Multi-loop Analysis, Thevenin & Norton Theorems
Week 2 – 2 (R, 16 Jul):, Source Transformation & Superposition, Intro to AC & Complex Numbers
Week 3 – 1 (T, 21 Jul): Frequency Response, Lowpass & Highpass Filters
Week 3 – 2 (R, 23 Jul): Mechatronics Introduction
Week 4 – 1 (T, 28 Jul): Bandpass Filters, Op-Amp - Introduction
Week 4 – 2 (R, 30 Jul): Op-Amp – Filters, Transfer functions and the time domain
Week 5 – 1 (T, 4 Aug): Time domain response, Control Theory
Week 5 – 2 (R, 6 Aug): PID control, Signals and ADC
Week 6 – 1 (T, 11 Aug): Logic, Sensors
Week 6 – 2 (R, 13 Aug): Mechatronics Actuators, review

Laboratory

All Labs will be "In-person". There will be 6 labs, and each lab will require a pre-lab and in-lab report submission.

Pre-Labs

Pre-labs for all lab sections will be **due 24 hours before the respective lab session**. Pre-labs will be submitted on Brightspace in the form of an online quiz. Preparing for the pre-lab will enable you to complete experiments efficiently.

Notes for Labs

- Lab attendance is a mandatory requirement of the course. A TA will take attendance at each lab session.
- Labs will be performed in groups of 2 students; lab results will be in groups of 2. Please ensure both names and student IDs are clearly stated in the submitted report. Lab groups will be established in the first week of labs (lab 1).
- There are 6 labs as follows:
    Lab 1: Mastering Lab Instruments and Circuit Fundamental (R, 9 Jul)
    Lab 2: DC Circuit Analysis and Network Simplification (R, 16 Jul)
    Lab 3: Exploring Time-Varying Signals and Transient Response (R, 23 Jul)
    Lab 4: Precision Control with PWM and Actuator (R, 30 Jul)
    Lab 5: Sensing, Feedback, and Integrated Mechatronic System (R, 6 Aug)
    Lab 6: Closed-Loop Control Systems: From Bang-Bang to PI (R, 13 Aug)

- Labs are 3 hours in duration and will be held in Room CB 4301. Labs will be held according to the schedule shown on Brightspace. You must attend your lab in the session you are registered. Changing sessions is not allowed without the instructor's permission. A TA will take attendance at each lab session.

- Lab attendance is a mandatory requirement of the course (to be eligible for a grade for that lab), which will be ensured during lab "Check-out". A grade of '0' in lab Check-out means you will get '0' in your lab report irrespective of your lab report grade.

- If for some reason a Lab needs to be rescheduled OR a Lab falls on one of the University holidays, students in those sections must try to rearrange their schedule to make up the lab in another of the regularly scheduled lab sessions, as arranged by the instructor.

- **Lab exemptions will not be granted for any reason.** If you are repeating the course, you must redo all the labs. This means doing all the pre-labs, attending all the lab sessions, and submitting all the reports. You may not resubmit any work that you have submitted in previous classes as it is considered a form of plagiarism.

- If you miss a lab for a valid reason, then you must request accommodation to the instructor for your section within three days of the lab session. Approved accommodation may include a makeup lab or adjusted grading depending on feasibility. No more than one lab can be accommodated through the term.

Lab Reports

- Lab reports will be required to ensure students have performed and understood the experiment and recorded and analyzed results.

- A lab report must be completed by **each student** during the lab and submitted before the end of the lab session. Reports will take the form of a Brightspace quiz with long-answer questions.

Final Group Project

- All students are required to complete a high-level design and analysis exercise. You will complete the project in a mixed-discipline group to act as design team submitting a proposal to management.

- Students are expected to form their own groups. We recommend grouping with your current laboratory table mates. The standard group size is 4 students. Exceptions for groups of 3 or 5 are possible with TA permission.
- If you are unable to find a group, the TAs will assign you.
- Groups should be selected by the end of the 2nd week of lectures.
- More information about the project and the requirements is located on the Brightspace page.

Final Exam

- The final exam will evaluate student understanding of all course concepts. As soon as the date of the final exam is confirmed by Scheduling and Examination Services (SES) it will be communicated to you by SES, and you can find it on "https://carleton.ca/ses/exam-schedule". The final exam will take place during the August examination period.

- 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 final examination after the final grades have been made available. This should be done no later than 3 days after the marks are posted.

- The final exam will be Closed-Book and Closed-Notes, and no reference materials are allowed. A formula sheet will be provided with the exam paper.

- No electronic device except for a non-graphing and non-programmable calculator is permitted in the final exam.

Exam format and proctoring statement
The final exam will be proctored and administered on campus during the final exam period. The exam will be paper-based, and answers will need to be written/indicated on the paper or Scantron sheets.

Deferred Final Examinations
Students who are unable to write the final examination because of a serious illness/emergency or other circumstances beyond their control may apply for accommodation by contacting the Registrar's office. Consult Section 4.3 of the University Calendar (https://calendar.carleton.ca/undergrad/regulations/academicregulationsoftheuniversity/examinations/)

Evaluation and Grading Scheme

The cumulative course grade will be determined as follows:

Component	Weight
Pre-labs	10%
Lab Reports	20%
Group Project	10%
Final Exam	60%

To pass the course, students must meet all the following requirements:
- a weighted average ≥ 40% on all term work (pre-labs, labs, project and midterm if written). In the case of a missed midterm the term work includes pre-labs, labs, and the project.
- a final exam grade ≥ 50%. Students who receive a final exam grade < 50% will receive a course grade of F regardless of their marks in the other components.
- an overall course grade ≥ 60%. This requirement comes from the Faculty of Engineering and Design policy for ECOR 103x courses (a final grade of C- or higher is required to pass).

Learning Outcomes

Upon successful completion of this course, students will be able to:
- Learn to analyze electrical circuits using techniques such as loop and nodal analysis, Norton and Thevenin analysis and superposition.

- Learn the basics of capacitors and inductors.
- Learn to analyze and design lowpass, highpass and bandpass filters.
- Gain experience performing electrical circuit simulation.
- Familiarize themselves with electrical laboratory hardware such as function generators and oscilloscopes.
- Interact with electrical hardware such as sensors, motors, and other devices to integrate them into a simple system.
- Analyze analog to digital signal conversion and control systems to solve basic problems.
- Apply the engineering design process to improve upon a simple system.
- Integrate the various lab components in the project design.
- Generate a project report based on the findings of the project lab experiment.
- Learn to work in a group environment.

Graduate Attributes

The Canadian Engineering Accreditation Board requires graduates of undergraduate engineering programs to possess 12 attributes: Graduate-Attributes.pdf (engineerscanada.ca) or GA's. 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 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. Accreditation metrics are based on courses common to all students in a program.

This following list provides the GAs that will be measured in this course, along with the indicators that are intended to develop and assess these attributes.

Graduate Attribute and Level	**Indicators or Area for Specialization**
GA-1: Knowledge base for Engineering	1.3 - Fundamental engineering concepts
GA-2: Problem Analysis	2.1 - Problem definition 2.2 - Approach to the problem 2.3 - Use of assumptions 2.4 - Interpreting the solution - validity of results
GA-5: Use of Engineering Tools	5.3 - Tools for design, experimentation, simulation, visualization, analysis 5.5 - Limitations of tools and assumptions inherent in their use
GA-6: Individual and Team Work	6.1 - Personal and group time management 6.2 - Group culture and dynamics 6.3 - Leadership: initiative and mentoring, areas of expertise, interdisciplinary teams
GA-11: Economics and Project Management	11.5 - Project definition and management techniques

Academic Integrity and Plagiarism

a) Please consult the Faculty of Engineering and Design information page about the Academic Integrity policy and our procedures: https://carleton.ca/engineering-design/current-students/fed-academic-integrity. Violations of the Academic Integrity Policy will result in the assignment of a penalty such as reduced grades, the assignment of an F in a course, a suspension or, expulsion.

b) One of the main objectives of the Academic Integrity Policy is to ensure that the work you submit is your own. As a result, it is important to write your own solutions when studying and preparing with other students and to avoid plagiarism in your submissions. The University Academic Integrity Policy defines plagiarism as "presenting, whether intentionally or not, the ideas, expression of ideas or work of others as one's own." This includes reproducing or paraphrasing portions of someone else's published or unpublished material, regardless of the source, and presenting these as one's own without proper citation or reference to the original source.

Examples of violations of the policy include, but are not limited to:

- Any submission prepared in whole or in part, by someone else;
- Using another's data or research findings without appropriate acknowledgment;
- Submitting a computer program developed in whole or in part by someone else, with or without modifications, as one's own;
- Failing to acknowledge sources of information through the use of proper citations when using another's work and/or failing to use quotations marks; and
- Unless explicitly permitted by the instructor in a specific course, the use of generative AI and similar tools to produce assessed content (such as text, code, equations, images, summaries, videos, etc.).

Generative Artificial Intelligence (AI)
Use of generative AI tools (such as ChatGPT) can serve you as a valuable learning tool. However like any reference, AI generated material should be properly cited. Claiming AI generated material as your own is a violation of academic integrity. You are accountable for your work, and if you simply parrot AI output it becomes a crutch and not a learning tool. You must be able to criticize or defend output you generate with AI. Exams are intended to assess your individual understanding and competency in the subject, AI tools will not be available to you in your exams.

Academic Accommodations

You may need special arrangements to meet your academic obligations during the term. For an accommodation request the processes are as follows:

Pregnancy obligation: Contact us 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 accommodation regarding a formally-scheduled final exam, you must complete the Pregnancy Accommodation Form (click here).

Religious obligation: Contact us 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 click here.

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 us 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). After requesting accommodation from PMC, contact us, if needed, to ensure that accommodation arrangements are made.

You should request your academic accommodations in the Ventus Student Portal, for each course at the beginning of every term. For in-term tests or midterms, please request accommodations at least two (2) weeks before the first test or midterm.

Please consult the PMC website for the deadline to request accommodations for formally-scheduled exams (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/equity/sexual-assault-support-services

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 will be provided to students who compete or perform at the national or international level. Contact us 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: https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf

Advising and Counselling services

Engineering Academic Advising

The Engineering Academic Support Service : https://carleton.ca/engineering-design/current-students/undergacademic-support/ assists undergraduate engineering students with course selection, registration, and learning support from first-year through to graduation.

Academic Advisors Contact : https://carleton.ca/engineering-design/current-students/undergradacademic-support/undergraduate-advisors/

Student Mental Health Service

The University and all members of the University community share responsibility for ensuring that the University's educational, work and living environments are free from discrimination and harassment. Should you have concerns about harassment or discrimination relating to your age, ancestry, citizenship, colour, creed (religion), disability, ethnic origin, family status, gender expression, gender identity, marital status, place of origin, race, sex (including pregnancy), or sexual orientation, please contact the Department of Equity and Inclusive Communities at equity@carleton.ca

We will strive to create an environment of mutual respect for all through equity, diversity, and inclusion within this course. The space which we work in will be safe for everyone. Please be considerate of everyone's personal beliefs, choices, and opinions.

General Regulations

Attendance

Students are expected to attend all lectures and lab periods in-person. Lab attendance is a mandatory requirement of the course. 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

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.

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