Carleton University Department of Electronics

Outline
ECOR 1032 Circuits and Mechatronics
Winter 2026

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.

Calendar 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: three hours per week Laboratories: three hours per week.

Instructors

Section D: Connor Kupchak (connor.kupchak@carleton.ca)
Section E: Tom Smy (TomSmy@cunet.carleton.ca)
Section F: Shulabh Gupta (shulabhgupta@cunet.carleton.ca)
Course Webpage: CU Brightspace
TA's: contact information to be posted on Brightspace

Textbook

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

Lectures will be in-person.
Section D: Mon/Wed 1:05-2:25pm Nideyinàn 231
Section E: Tues/Thurs 8:35-9:55am Nideyinàn 231
Section F: Tues/Thurs 1:05-2:25 Health Sciences 1301

The 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 1: Introduction and basic concepts Week 2: Ohm's law, KVL, KCL, single loop circuits
Week 3: Single and multi-node circuits
Week 4: Multi-loop and Thevenin's theorem
Week 5: Source transformation, superposition, complex numbers
Week 6: Time varying signals, AC circuits, filters, Winter break week!
Week 7: Bandpass filters, Midterm
Week 8: Introduction to mechatronics, ADC
Week 9: ADC performance and intro to logic gates
Week 10: Boolean analysis and intro to sensors
Week 11: Sensor design and control
Week 12: Signals and actuators
Week 13: Catch-up and 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. Labs will begin starting the week of January 12, all lab sections meet in the Canal Building (CB) room 4301.

Pre-Labs

Pre-labs for all lab sections will be **due on Sunday evening each week** starting on January 11. 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.

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 and lab reports will be submitted by the group of 2. Please ensure both names and student IDs are clearly stated on 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 (Week of Jan. 12)
  Lab 2: DC Circuit Analysis and Network Simplification (Week of Jan. 26)
  Lab 3: Exploring Time-Varying Signals and Transient Response (Week of Feb 9)
  Lab 4: Precision Control with PWM and Actuator (Week of March 2)
  Lab 5: Sensing, Feedback, and Integrated Mechatronic System (Week of March 9)
  Lab 6: Closed-Loop Control Systems: From Bang-Bang to PI (Week of March 16)
  Mechantronics Project: (Weeks of March 23 and 30)

- Labs are 3 hours in duration and will be held in Room CB4301. Labs will be held according to the schedule shown on Brightspace. You must attend your lab in the section you are registered. Changing sections is not allowed.
- 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.
- **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 a lab is missed for a valid reason you must request accommodation to the instructor for your section within three days of the lab session. Approved accommodations 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 analysed 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.
- Lecture Sections: Group members must be registered in the same Lecture Section (A, B, or C). However, members may belong to different Lab sections. TA Assignment: If you are unable to find a group, the TAs will assign you.
- Groups should be selected by the end of the 4th week of lectures.
- More information about the project and the requirements is located on the Brightspace page.

Midterm Exam

- The midterm exam will be held in-person in the final class in the week following to the Winter break (February 25 or 26 depending on your section).
- The midterm 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 midterm exam.
- Students who miss the midterm exam for any reason will have the grade weight of the midterm exam added to the final exam.

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 December 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 the 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%
Project	5%
Midterm Exam	15%
Final Exam	50%

To pass the course, students must meet all the following requirements:

- a weighted average $\geq 40\%$ 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 $\geq 50\%$. 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 $\geq 60\%$. 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).
- Due to the high volume of students registered in this course, the instructors may implement AI tools to assist in the grading of coursework.

Learning Outcomes

By the end of this course, students should:

- 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 Graduate Attributes (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

Self-Declaration form and 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/Head TA concerned and for submitting a self-declaration form no later than three (3) days after the date/deadline of term work including test/midterm, labs, assignments. Any alternate arrangements made with the instructor for submission of term work should be made as soon as possible and in all cases before the last day of classes in the term as published in the academic schedule.

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 quotation marks; and

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 Accommodation

Carleton University is committed to providing academic accessibility for all individuals. You may need special arrangements to meet your academic obligations during the term. The accommodation request processes, including information about the*ăAcademic Consideration Policy for Students in Medical and Other Extenuating Circumstances*, are outlined on the Academic Accommodations website (students.carleton.ca/course-outline).

Advising and Counselling services

Engineering Academic Advising

The Engineering Academic Support Service : https://carleton.ca/engineering-design/current-students/undergraduate-academic-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/undergrad-academic-support/undergraduate-advisors/

Student Mental Health Service

As a university student you may experience a range of mental health challenges that significantly impact your academic success and overall well-being. Carleton's Wellness Services Navigator https://wellness.carleton.ca/navigator/ is designed to help students connect with mental health and wellness resources. If you need to talk to someone, please reach out for assistance: https://carleton.ca/health/emergencies-and-crisis/.

Learning and Working Environment

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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