Carleton University

Department of Electronics

Fall 2025

ELEC 2501: Circuits and Signals

Introduction

This course provides a foundation in the principles of electrical circuits and signal analysis, which are essential for all areas of electrical, computer, and systems engineering. Students will learn how to model and analyze basic circuit elements—resistors, capacitors, inductors, sources—and apply fundamental laws such as Ohm's law and Kirchhoff's voltage and current laws to solve practical problems. The course emphasizes systematic circuit analysis techniques, including node-voltage, mesh-current, and Thevenin/Norton equivalents, to handle both direct current (DC) and alternating current (AC) circuits. Students will also explore transient and steady-state responses, frequency-domain analysis, and the role of energy and power in electrical systems. In parallel, the course introduces the concept of signals as time-varying functions that carry information and energy.

Course Description and Requirements

Properties of Signals; Basic circuit elements: voltage and current sources, Kirchhoff's laws, linearity, superposition; Thevenin and Norton's theorems; AC steady-state analysis: impedance, admittance, phasors, frequency response; Transient response of RL and RC circuits: form of response, initial and final conditions RLC circuits: resonance; Poles and zeros, Bode Plots; Average power, maximum power transfer, power factor and complex power.
Includes: Experiential Learning Activity
Prerequisite(s): MATH 1005 and (PHYS 1004 or PHYS 1002) are pre-requisites and students without them will be deregistered.
Lectures 3 hours per week.
Laboratory and problem analysis 3 hours per week alternate weeks.

Instructor

Shichao Liu Section A Room: 7042 Minto Case Phone: ext 5762 shichaoliu@cunet.carleton.ca Office Hour: by appointment	Hubert Jean-Ruel Section B Room: 7068 Minto Case Phone: ext. 5578 hubertjeanruel@cunet.carleton.ca Office Hour: by appointment

Textbook

J. D. Irwin and R. M. Nelms, Basic Engineering Circuit Analysis, 12th edition, (online interactive version: zybook (https://www.zybooks.com/catalog/basic-engineering-circuit-analysis/ for more details), Wiley.

Estimated Text Cost: Based on Wiley website, E-book Rental (150 days), USD 51.00; Print, USD 142.95; zybook version, USD 64.00

Lecture Outline

In person, Tuesdays and Thursdays
The following topics will be covered during the course lectures.

Properties of Signals
Basic circuit elements: voltage and current sources, Kirchhoff's laws, linearity, superposition.
Thevenin and Norton's theorems
AC steady-state analysis: impedance, admittance, phasors, frequency response.
Transient response of RL and RC circuits: form of response, initial and final conditions
RLC circuits: resonance
Poles and zeros, Bode Plots
Average power, maximum power transfer, power factor and complex power

Laboratory and Problem Analysis Sessions

3 hours alternate weeks as per schedule and location posted on Carleton Central and Brightspace.

Notes for Labs

- There are five labs in this course. All Laboratories for ELEC2501 are being delivered in a completely in-person format. All laboratories will take place in Mackenzie 4195.
- Each student is required to independently complete and submit all laboratory reports. Lab reports should convey all data, calculations, graphs etc. and the necessary conclusions and discussions should be added at the end. Ensure you know how to do this efficiently before your first lab. Students have the choice of program to prepare their reports and data but reports must be neat and legible otherwise a discretionary deduction may be applied. All reports are to be submitted as a single .PDF file online. Lab reports are due at Midnight on the next day of your lab section, please allow yourself enough time to check that you have submitted the correct file. A penalty of 20% per day will be applied to late reports.
- Lab attendance is mandatory, TAs will be taking attendance and records will be maintained for the term. Lab exemptions are not granted under any circumstances for accreditation purposes, students completing the course must complete all labs and prepare original laboratory reports. Unexcused lab absences must still be completed to be eligible to pass the course. In the case of a missed lab for medical reason or accepted excused absence, a request for a makeup lab (with reason provided) must be made within 48 hrs of the missed lab. Failure to do this will result in a grade of zero on the missed lab and an unsatisfactory completion of the course requirements. Makeup lab requests should be directed to the course instructor.
- Additionally, the following lab policies must be adhered to:
    - Students must attend their lab session on time.
    - Students must complete their lab in their allotted time.
    - Students must always properly log out of their workstation when done.

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 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 but within 3 days of the missed due date. If this is not possible after discussion with the instructor, alternate arrangements must be made before the last day of classes in the term as published in the academic schedule.

Notes for PAs:

- There are 5 PA sessions for this course throughout the term and they will occur on a biweekly basis alternating with labs. The PA sessions will be held in person in the room listed on Carleton Central. PA session questions are assigned out of J. D. Irwin and R. M. Nelms, Basic Engineering Circuit Analysis 12th edition. You will be required to have the assigned textbook to complete this.
- The last 50 minutes of each PA session will consist of an in-person, written quiz to be delivered and graded by your TA. Quizzes are to be completed individually and will be closed book. Your final quiz grade will be taken as the best 4 of 5 quizzes completed during the term. Make-up quizzes will not be granted for any reason.

Evaluation and Grading Scheme

The cumulative course grade will be determined as follows:

Labs	20%
Assignment	5%
PA Quizzes	15%
Midterm (in-class)	20%
Final	40%

To pass this course you need:

- A minimum of 50% on the combined term mark (labs / PA quiz / assignment / midterm).
- A minimum of 40% on the final exam.
- You also need to have complete all labs to be eligible to pass this course.

Midterm:

- There will be one midterm (in-class, in-person) in the course, 80 minutes in duration.
- For students missing the midterm due to a valid reason, the weight of the midterm transferred to final. A make-up midterm will not be granted.

Assignment:

- There will be a 1 Assignment for the course. However, it will be broken up into 2 parts that are due at the same time.

Final Exam:

- Final exam will be closed-book, in-person, 180 minutes, and to be officially scheduled by Exams and Schedule.
- **Final exams are for evaluation purpose and will not be returned to students.**

Learning Outcomes

- Use appropriate SI units for currents, voltages and circuit elements
- Define voltage, current, power and their relationships
- Define and apply Ohm's law
- Analyze single-loop and single-node-pair circuits
- Determine the equivalent resistance of a network
- Transform wye resistor network into delta resistor network and vice versa

- Apply voltage and current division in circuits
- Analyze electric circuits to determine voltage and currents in the network
- Calculate currents and voltages in a circuit using loop analysis or nodal analysis
- Analyze electrical circuits using the principle of superposition
- Calculate Thevenin and Norton equivalent circuits for linear circuits
- Apply maximum power transfer theorem to determine optimal load
- Use circuit models for inductors and capacitors to calculate voltages, currents and powers
- Calculate voltages and currents in first-order transient circuits
- Perform phasor and inverse phasor transformations Draw phasor diagrams
- Calculate equivalent impedance and admittance for circuits consisting of basic circuit elements
- Apply circuit analysis techniques to frequency-domain circuits
- Calculate instantaneous, average, real, reactive and complex power and power factor in ac circuits
- Calculate average and RMS value for a periodic waveform
- Calculate the maximum average power transfer for a load in an ac circuit
- Sketch Bode plots for a network function
- Analyze series and parallel resonant circuits to determine voltages and currents in circuit

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 course (ELEC 2501) will score attributes 1.4 Discipline Specific concept , 2.2 Approach to problem, 2.3 Use of assumptions, 2.4 interpreting the solution, 7.5 Notetaking skills and listening skills. They are scored through the responses provided in assignments, quizzes, prelab and lab reports, presentations, final exams. The graduate attribute scores may in some cases be derived from graded material, however the graduate attribute scores are not used in determination of the final grade for the course.

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.).

Academic Accommodations

Carleton 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 Academic Consideration Policy for Students in Medical and Other Extenuating Circumstances, are outlined on the Academic Accommodations website (students.carleton.ca/course-outline).

Use of Course Materials

Classroom teaching and learning activities, including lectures, discussions, presentations, etc., by both instructors and students, are copy protected and remain the intellectual property of their respective author(s). All course materials, including PowerPoint presentations, outlines, and other materials, are also protected by copyright and remain the intellectual property of their respective author(s). Students registered in the course may take notes and make copies of course materials for their own educational use only. Students are not permitted to reproduce or distribute lecture notes and course materials publicly for commercial or non-commercial purposes without express written consent from the copyright holder(s).

AI Use in this course

Students may use AI tools for basic word processing and formatting

functions, including:

• Grammar and spell checking (e.g., Grammarly, Microsoft Word Editor)

• Basic formatting and design suggestions (e.g., Microsoft Word's formatting tools, PowerPoint Design editor)

Documenting AI Use: It is not necessary to document the use of AI for the permitted purposes

listed above.

As our understanding of the uses of AI and its relationship to student work and academic integrity continue to evolve, students are required to discuss their use of AI in any circumstance not described here with the course instructor to ensure it supports the learning goals for the course.