

## ELEC 2602: Electric Machines and Power

### Introduction

In this course you will learn the fundamentals of electric power generation and distribution and its many applications especially transformers, motors and generators. Laboratories will reinforce understanding of operating characteristics of transformers, motors and generators.

### Course Description and Requirements

Modeling and analysis of basic electric power systems. Single-phase and three-phase circuits: real and reactive power, per-phase analysis, power factor correction. Electro-mechanical energy conversion: operation, characteristics and analysis of transformers, DC-, induction-, and synchronous electric machines. Motor and generator operation.

Includes: Experiential Learning Activity

**Prerequisite(s):** PHYS 1004 and ELEC 2501, and second-year status in Engineering.

**Lectures** 3 hours per week.

**Laboratory and problem analysis** 3 hours per week alternate weeks.

### Instructor

Professor B. Syrett, Room ME4150

Email: [BarrySyrett@cunet.carleton.ca](mailto:BarrySyrett@cunet.carleton.ca)

Course Webpage: on Brightspace

### Textbook

1) Lecture notes are provided on Brightspace

2) Recommended (but not necessary) textbook: S.J. Chapman: "Electric Machinery Fundamentals", 5<sup>th</sup> edition, McGraw Hill. Hardcover copy can be ordered from Carleton bookstore for \$250.00. It can also be ordered on Amazon or other web storefronts in either paperback or hardcover, new or used, probably for less money.

### Lecture Outline

In person, Wednesday. & Friday. 11:35-12:55, Azrieli 302

The following topics will be covered during the course lectures with an approximate schedule.

Week 1: Introduction; review phasor analysis of single-phase AC circuits

Week 2: AC Power analysis

Week 3-4: Magnetic principles; single-phase transformers

Week 5-6: Three-phase power

Week 7: Three-phase transformers and power distribution

Week 8: DC Machines

Week 9-10: Induction (asynchronous) machines

Week 11-12: Synchronous machines

## Laboratory and Problem Analysis Sessions

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

### Notes for Labs

- There are four labs as follows:
  - Lab 0: Electrical Safety (no report but an online quiz graded SAT/UNSAT to complete)
  - Lab 1: Transformers
  - Lab 2: DC Motor (DC Motor/Generator, Universal Motor)
  - Lab 3: Three-Phase Induction Motor
  - Lab 4: Three-Phase Synchronous Motor/Generator
- Labs are 3 hours in duration and will be held in Room Minto 6030. Labs and PA sessions usually “alternate” from week to week and will be held according to the schedule shown on the course module in 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.
- 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.
- Attend each lab punctually. Be prepared for the lab experiment by reading the lab instruction sheets before entering the lab. Some labs have a pre-lab exercise that must be completed before the start of your lab period. You are not permitted to do the lab unless the prelab is completed. The TA will check that the pre-lab has been completed.
- A lab report will be submitted online for each lab and lab and by each student. A template for each lab report will be provided. Lab reports are due by midnight on the day of the lab. Late lab reports must still be submitted. One day late it will only be worth 50%. Two days late, it is worth 0.

### Notes for PA Sessions

- Several problems will be assigned each week as homework to help understand the lecture material, prepare for the midterm exams and final exam. To learn the course material, **IT IS ESSENTIAL THAT YOU ATTEMPT SOLUTIONS FOR THESE PROBLEMS BEFORE THE PA SESSION**. Solutions to these problems will be reviewed in the PA sessions.
- Due to a shortage of TAs this term, PA sessions will comprise videos of previous online PA sessions so students can view them any time during the week that the problems are assigned. The course instructor will arrange a Zoom meeting in the week following the PA session to answer questions about the problems assigned the previous week and their solution or important concepts addressed in the problems, but not to repeat a complete solution already contained in the video.

## 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.

## Evaluation and Grading Scheme

The cumulative course grade will be determined as follows:

- 60% Final Exam on campus during normal scheduled exam period. Final exams are for evaluation purposes only and will not be returned to the student.
- 30% for two midterm exams on campus scheduled outside of class time (15% each)
  - First midterm, date and room TBA
  - Second midterm, date and room TBA
- 10% Laboratories and you must complete and submit all 4 lab reports on due date and time.

To pass the course you need:

- Minimum overall grade of 50%
- Have completed all labs and submitted all 4 lab reports, plus the quiz on Lab 1.
- Minimum of 50% on the final exam.
- Students must complete at least one midterm to be eligible to pass, otherwise a grade of F can be assigned. If a student is absent from one midterm the weighting will be moved to the final.
- For students missing a midterm, one deferred midterm examination will be arranged, but the examination will only be for pedagogical purposes and any grade assigned will not contribute to the cumulative course grade.
- Grades will be assigned based on the criteria listed above ONLY and converted into a letter grade as defined in the Carleton Course Calendar.

## Learning Outcomes

Upon successful completion of this course, students will be able to:

- 1) Identify the main components in an electrical power distribution system.
- 2) Describe the basic concepts of magnetic circuits as applied to electric machines.
- 3) Explain the two basic principles (generation of force and emf) that govern electromechanical energy conversion.
- 4) Describe an electrical model and the operating principle of single- and three-phase transformers.
- 5) Calculate real power, apparent power, complex power, the power triangle, power factor and power factor correction.
- 6) Use phasors to analyze balanced three-phase circuits in wye- or delta-configuration using per-phase analysis.
- 7) Use electrical models for describing the operating principles and characteristics of DC machines, synchronous machines and induction machines either as motor or generator.
- 8) Verify and validate laboratory measurements on electric machines to determine steady-state characteristics involving voltage, power, current, power factor, and torque.

## 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		Indicators
1. A knowledge base for Engineering	Demonstrated competence in university level mathematics, natural sciences, engineering fundamentals, and <u>specialized engineering knowledge appropriate to the program.</u>	Percentage is applied to questions assessing knowledge base in discipline specific knowledge area such as Electrical Engineering.
2. Problem Analysis	An ability to use appropriate knowledge and skills to identify, formulate, analyze, and solve complex engineering problems in order to reach substantiated conclusions.	<ol style="list-style-type: none"><li>1. Problem definition</li><li>2. Approach to the problem</li><li>3. Use of assumptions</li><li>4. Interpreting the solution, validity of results</li></ol>

## 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

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](mailto: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>