Carleton University
Department of Electronics
Engineering ELEC 2602 Electric Machines and Power

Course Outline **January 4, 2023**

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.

Description

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.A. Syrett Room ME4150
Email: bas@doe.carleton.ca
Course web page at : Brightspace

Textbook

1) Lecture materials provided online or in course pack. **You are expected to read the notes for the next lecture as assigned in class, and come to class prepared with some understanding of the material.**

2) Textbook (recommended) is S.J. Chapman: "Electric Machinery Fundamentals", 5th edition, McGraw Hill. Order from Amazon as it has not been ordered from the bookstore. You can get along without it if you wish. There are also many other reference textbooks you can consult in the library. If I get enough requests in the first week I will order it for the bookstore.

Lecture Outline (Tuesday & Thursday. 10:00-11:30, MC 5050)

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 PA Sessions (3 hours, alternate weeks)

Labs will also be performed synchronously by login to control LabVolt equipment remotely.
Labs and PA sessions will be held according to the schedule shown on the course website

There are four technical labs plus an initial lab on electrical safety.

Lab 0: Electrical Safety (no report but a quiz graded SAT/UNSAT to complete)
(must be passed to continue in the course)
Lab 1: Single-Phase Transformer
Lab 2: DC Motor (Separately Excited, Series-, Shunt-, Compound DC Motor)
Lab 3: Three-Phase Induction Machine (Induction Motor, Asynchronous Generator)
Lab 4: Three-Phase Synchronous Machine (Synchronous Motor, Synchronous Generator)

Notes for Lab and PA Sessions

- Lab and PA sessions are 3 hours in duration. Labs and PA sessions usually "alternate" from week to week and will be held according to the schedule shown on the course website. You must attend your lab and your PA session in the session you are assigned. Changing session is not allowed.

- If for some reason an entire Lab or PA session needs to be rescheduled OR a Lab or PA session falls on one of the University holidays, students in those sections must 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. If you miss a lab for a medical reason, and supply an original of a Doctor's note to the course instructor ASAP, it may be possible to complete it in another regularly scheduled lab period with the instructor's permission (usually within a few days of your missed lab period).

- 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 sign your lab book prior to starting the lab and verify that the pre-lab is completed.

- A lab report will be submitted online for each lab and lab and by each student. This report should include the measurement set-up, a clear description of the measurement performed, data, sample calculations, discussion of results and conclusions. It is NOT a formal lab report with purpose, apparatus, and observations. 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.

- 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.

Course Grade

- 60% in person Final Exam (During normal scheduled exam period)
- 30% for 2 in person midterm exams scheduled outside of class time (15% each)
  First midterm on Thursday February 16 at 6:30-8:30 pm
  Second midterm on Thursday March 30 at 6:30-8:30 pm.
- 10% in person Laboratories and you must complete and submit on due date all lab reports.

To pass the course you need:

- Minimum overall grade of 50%
- Have completed all Labs and submitted all lab reports, plus the quiz on Lab 0.
- Minimum of 50% on the final exam. (That is 30 out of 60 as the exam is worth 60% of your final grade)
- 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 can be moved to the final.
- 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

1) Understand the basic concepts of magnetic circuits as applied to electric machines.
2) Understand the two basic principles (generation of force and emf) that govern electromechanical energy conversion.
3) Understand electrical model, operation principles, and characteristics of DC electric machine (motor and generator)
4) Understand electrical model, operation principles, and characteristics of synchronous electric machine (motor and generator)
5) Understand electrical model, operation principles, and characteristics of induction electric machine (motor and generator)
6) Understand phasors and phase sequence applied to three-phase circuits.
7) Understand real power, apparent power, complex power, the power triangle, power factor and power factor correction.
8) Be able to analyze balanced three-phase circuits in wye- or delta-configuration using per-phase analysis.
9) Understand model and operating principle of single- and three-phase transformers.
10) Make laboratory measurements on electric machines to determine steady-state characteristics involving voltage, power, current, power factor, and torque.
11)Demonstrate an awareness of electrical safety practices and procedures.

Plagiarism

Plagiarism is a serious instructional offense that will not be tolerated. It involves passing off someone else's original work as your own. Most cases of plagiarism can be avoided by carefully citing sources for any ideas, statements, results etc. that are not your own. Please refer to the section on instructional offenses in the Undergraduate Calendar for additional information.

Academic Accommodation

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

Pregnancy obligation**:** write to me 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 visit the Equity Services website: http://carleton.ca/equity/accommodation/student_guide.htm

Religious obligation**:** write to me 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 visit the Equity Services website: http://carleton.ca/equity/accommodation/student_guide.htm

Students with disabilities requiring academic accommodations**:** in this course must register with the Paul Menton Centre for Students with Disabilities (PMC) for a formal evaluation of disability-related needs. Documented disabilities could include but are not limited to mobility/physical impairments, specific Learning Disabilities (LD), psychiatric/psychological disabilities, sensory disabilities, Attention Deficit Hyperactivity Disorder (ADHD), and chronic medical conditions. Registered PMC students are required to contact the PMC, 613-520-6608, every term to ensure that I receive your *Letter of Accommodation*, no later than two weeks before the first assignment is due or the first in-class test/midterm requiring accommodations. If you only require accommodations for your formally scheduled exam(s) in this course, please submit your request for accommodations to PMC by the last official day to withdraw from classes in each term. For more details visit the PMC website: http://www.carleton.ca/pmc/students/acad_accom.html

Graduate Attributes:

The Canadian Engineering Accreditation Board (CEAB) has established that an institution must demonstrate that graduates of its programs possess certain defined attributes. The institution must also implement and employ processes to demonstrate that program outcomes are being assessed in the context of these attributes, and that the results of such assessments will be applied to the further development of programs. The graduate attributes relevant to this course are:

1. **A knowledge base for engineering:** Demonstrated competence in university level mathematics, natural sciences, engineering fundamentals, and specialized engineering knowledge appropriate to the program.
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.

This course (ELEC 2602) will score attributes #1 (Knowledge Base) and #2 (Problem Analysis). They are scored through the responses provided in assignments, quizzes, and final exams. The graduate attribute scores will be derived from graded material, however they are for internal use only.