ELEC ENG 3PI4
Energy Conversion

COURSE OUTLINE

Please refer to course website for updated information.

COURSE DESCRIPTION

Analyze, model, and predict the performance of energy conversion devices and systems including single-phase and balanced three-phase systems, transformers, introduction to electric machines, AC generators and AC motors.

PRE-REQUISITES AND ANTI-REQUISITES

Pre-requisite(s): ELECENG 2CJ4, ELECENG 2FH3 or ELECENG 2FH4, and ELECENG 2CI5 or ELECENG 2CI4
Anti-requisite(s): none

SCHEDULE and MODE OF DELIVERY

The material for this course will be delivered in person and therefore attendance is required.

Lectures:	Monday	5:30 - 6:20 pm
	Wednesday	5:30 - 6:20 pm
	Thursday	10:30 - 11:20 am (tutorial time used for lecture)
Tutorial:	Friday	5:30 - 6:20 pm (lecture time used for tutorial)

Labs: Monday to Friday (Every Other Week) — Starting Monday January 26th

L01 Monday	2:30 pm – 5:20 pm	L02 Monday	6:30 pm – 9:20 pm
L03 Tuesday	2:30 pm – 5:20 pm	L04 Tuesday	6:30 pm – 9:20 pm
L05 Wednesday	2:30 pm – 5:20 pm	L06 Wednesday	6:30 pm – 9:20 pm
L07 Thursday	2:30 pm – 5:20 pm	L08 Thursday	6:30 pm – 9:20 pm
L09 Friday	2:30 pm – 5:20 pm	L10 Friday	6:30 pm – 9:20 pm

Starting Monday February 2nd

L11 Monday	2:30 pm – 5:20 pm

INSTRUCTOR

Dr. Phillip Kollmeyer
E-mail: kollmeyp@mcmaster.ca
Office: ITB 113
Office Hours**:** By appointment – see course website for details

TEACHING ASSISTANTS

Names, contact information and office hours are provided on the course website.

COURSE WEBSITE

The Course Management System will be **Avenue to Learn**. The student is required to **check the system** for assignment, course related material, and posted announcements.
http://avenue.mcmaster.ca

COURSE OBJECTIVES

By the end of this course students should be able to analyze, model, and predict the performance of power devices and systems including single-phase and balanced three-phase systems, transformers, and generators and motors. In addition the students must be able to measure the parameters for these models using standard tests.

After completing this course, the student should be able to do the following things correctly.

1. Given an electromechanical system including an electric machine and a mechanical load with different torque-speed characteristics, find torque, acceleration, speed, position, and power.
2. Given an energy conversion system, using fundamentals of electromagnetism, draw and analyze the equivalent electric circuit.
3. Derive and apply the relevant equations of single-phase and three-phase transformers.
4. Derive and apply the relevant equations of three-phase induction machines: motors and generators.
5. Derive and apply the relevant equations of multi-phase permanent-magnet synchronous motors and three-phase synchronous generators.
6. Derive and apply the fundamental equations of special motor drives: DC Machines, switched reluctance, stepper, brush-less DC, and electronic motor drives.

CEAB GRADUATE ATTRIBUTES (GAS)

Note: The CEAB Graduate Attributes (GAs) defined in this section are measured throughout the course and form part of the Department's continuous improvement process. They are a key component of the accreditation process for the program and will not be taken into consideration in determining a student's actual grade in the course. For more information on accreditation, please ask your instructor or visit: http://www.engineerscanada.ca

Attributes	Indicators		Measurement Method(s)
	Number	Description	
Problem Analysis	2.2	Proposes problem solutions supported by substantiated reasoning, recognizing the limitations of the solutions.	exam
Investigation	3.2	Synthesizes the results of an investigation to reach valid conclusions.	exam
Design	4.1	Defines the problem by identifying relevant context, constraints, and prior approaches before exploring potential design solutions.	exam
Professionalism	8.2	Integrates appropriate standards, codes, legal and regulatory factors into decision making.	exam
Impact of Engineering on Society and the Environment	9.1	Evaluates the environmental impact of engineering activities, identifies uncertainties in decisions, and promotes sustainable design.	exam

ASSUMED KNOWLEDGE

It is assumed that the students have knowledge of circuit analysis and electromagnetic fundamentals.

COURSE MATERIALS

Required Texts:

- Textbook: *"Electric Machinery Fundamentals"* by Stephen J. Chapman, McGraw--Hill, 5th edition, 2012, ISBN: 9780073529547.

Optional Texts (these are the course references):

- *"Electric Machines and Drives"*, Gordon R. Slemon, Addison Wesley, ISBN 0-201-57885-9, 1992.
- *"Fundamentals of Electric Drives"*, By: M. A. El-Sharkawi, 1st Edition, PWS Pub. Co., ISBN: 0- 534-95222-4, 2000.
- *"Electric Motor Drives: Modeling, Analysis, and Control"*, By: R. Krishnan, 1st Edition, Prentice Hall, ISBN: 0-13-091014-7, 2001.

Calculator:
Any calculator can be used on quizzes, tests and examinations.

COURSE OVERVIEW

Week	Topic	Readings
1 - 2	Review of Single and Three Phase AC Power	Chapman: 1.1, 1.9, Appendix A
3 - 4	Fundamentals of Electrical and Electromechanical Energy Conversion	Chapman: 1.2-1.7
5 - 6	Transformers	Chapman: 2.1-2.7, 2.9-2.12
7	Fundamentals of AC machines	Chapman: 3.1-3.2,3.4-3.5,3.7
8 - 10	Synchronous Generators	Chapman: 4.1-4.7, 4.11
10 - 12	Induction Motors	Chapman: 6.1-6.5, 6.11, 6.13
13	Other machines	

A more detailed timeline is available on the course website.
At certain points in the course, the instructor may modify elements of the course and will notify students accordingly (in class, on the course website).

HOMEWORK

Homework	Topic
1	Three phase power
2	Transformers
3	AC Machines
4	Synchronous Generators
5	Induction Machines

LABORATORY TOPICS

Week (tentative)	Lab	Topic
4	1	Three-phase Power and Electric Machine Basics
8	2	Transformers
10	3	Synchronous Generators
12	4	Induction Motors

LABORATORY OPERATION

- Each student in the course is required to pass the lab safety quiz prior to attempting any of the laboratories. The quiz will be available on Avenue to Learn.
- Access to all labs is restricted in the interest of security and safety.
- The TA will open the lab at regularly scheduled lab times.
- The labs will be performed in groups of two or three students.

ASSESSMENT

Course Evaluation:

Components	Weight
Homework (four assignments)	8%
Lab Evaluation (four labs)	12%
Midterm Exams (two exams, around one hour each)	30%
Final Exam (2.5 hours, scheduled and supervised by the registrar)	50%
Total	**100%**

Grading and Evaluation Policies:

- There are four (4) homework assignments, four (4) laboratories, two (2) midterm exams, and one (1) final exam to be evaluated in this course.

- Due dates and submission policies:
  - **Homework**
    - **Due:** Dates posted on avenue to learn, three-day grace period
    - **Format:** Written response to questions showing all work and results
    - **Submission:**
      - Electronic via Avenue to Learn
      - Individual submission by each student

        - **Grading:** Scored 0 to 100
    - **Lab Report**
        - **Due**: One week after lab session, three-day grace period
        - **Format:** Complete the lab report content as described in the manual.
        - **Submission:**
            - Electronic submission via Avenue to Learn
            - One report per group with each member's name on it
        - **Grading:** Scored 0 to 100

- Policy for missed exams/labs/homework with MSAF:
    - Lab: Allows for makeup of lab(s) at end of course
    - Homework:
        - Weight of missed homework(s) transferred to remaining homework
    - Midterm: Weight of missed midterm(s) transferred to final exam

- **Exam policies**
    - Use of books, notes, other copied materials, computers or cell phones are not allowed during exams.
    - An equation sheet will be provided with the exam. No written note sheet will be allowed.
    - Students who miss a midterm without submitting an MSAF will be given a score of zero.
- Conversion from percentage to letter grade will be by way of the standard scale defined by the Office of the Registrar. In order to pass this course, you must complete all the labs.

Note: The use of ChatGPT or other AI tools is not allowed for the completion of any content in this course – specifically labs and homework assignments. The labs and homeworks are designed to help students learn the material, use of AI tools defeats the purpose of learning in this context. If the use of AI tools is detected, a zero will be assigned to the respective lab or homework.

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. It is your responsibility to understand what constitutes academic dishonesty. Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at https://secretariat.mcmaster.ca/university-policies-proceduresguidelines/

The following illustrates only three forms of academic dishonesty:

- plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
- improper collaboration in group work.
- copying or using unauthorized aids in tests and examinations.

AUTHENTICITY / PLAGIARISM DETECTION

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to www.mcmaster.ca/academicintegrity.

COURSES WITH AN ON-LINE ELEMENT

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure please discuss this with the course instructor.

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, including lectures by University instructors.
The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

CONDUCT EXPECTATIONS

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the Code of Student Rights & Responsibilities (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, whether in person or online. It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

ACADEMIC ACCOMMODATIONS

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's Academic Accommodation of Students with Disabilities policy.

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students should submit their request to their Faculty Office normally within 10 working days of the beginning of term in

which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations.

Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

REQUESTS FOR RELIEF FOR MISSED ACADEMIC WORK

McMaster Student Absence Form (MSAF): In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar "Requests for Relief for Missed Academic Term Work".

EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.

www.eng.mcmaster.ca/ece

Electrical and Computer Engineering Lab Safety

Information for Laboratory Safety and Important Contacts

This document provides important information for the healthy and safe operation of ECE instructional laboratories. This document is required reading for all laboratory supervisors, instructors, researchers, staff, and students working in or managing instructional laboratories in ECE. It is expected that revisions and updates to this document will be done continually. A McMaster University lab manual is also available to read in every laboratory and online https://hr.mcmaster.ca/app/uploads/2019/07/2019-McMaster-Lab-Manual.pdf

General Health and Safety Principles

Good laboratory practice requires that every laboratory worker and supervisor observe the following whether conducting lab work at school or at home:

1. Food and beverages are not permitted in the instructional laboratories.
2. A Laboratory Information Sheet on each lab door identifying potential hazards and emergency contact names should be known.
3. Laboratory equipment should only be used for its designed purpose.
4. Proper and safe use of lab equipment should be known before using it.
5. The course TA leading the lab should be informed of any unsafe condition.
6. The location and correct use of all available safety equipment should be known.
7. Potential hazards and appropriate safety precautions should be determined, and sufficiency of existing safety equipment should be confirmed before beginning new operations.
8. Proper waste disposal procedures should be followed.
9. Personal ergonomics should be practiced when conducting lab work. https://bit.ly/3fOE71E
10. Current University health and safety issues, and protocol should be known. https://hr.mcmaster.ca/resources/covid19/workplace-health-and-safety-guidance-during-covid-19/

Location of Safety Equipment

Fire Extinguisher
On walls in halls outside of labs

First Aid Kit
Main Lobby of ITB or
dial “88” after 4:30 p.m.

Telephone
On the wall of every lab near the door

Fire Alarm Pulls
Near all building exit doors on all floors

Who to Contact

Emergency Medical / Security: On McMaster University campus, call Security at extension **88** or **905-522-4135** from a cell phone.
Non-Emergency Accident or Incident: Immediately inform the TA on duty or Course Instructor.
University Security (Enquiries / Non-Emergency): Dial 24281 on a McMaster phone or dial 905-525-9140 ext. 24281 from a cell phone.
See TA or Instructor: For problems with heat, ventilation, fire extinguishers, or immediate repairs
Environmental & Occupational Health Support Services (EOHSS): For health and safety questions dial 24352 on a McMaster phone or dial 905-525-9140 ext. 24352 from a cell phone.
ECE Specific Instructional Laboratory Concerns: For non-emergency questions specific to the ECE laboratories, please contact 24103.

In Case of a Fire (On Campus Dial 88)

When calling to report a fire, give name, exact location, and building.

1. Immediately vacate the building via the nearest Exit Route. Do not use elevators!
2. Everyone is responsible for knowing the location of the nearest fire extinguisher, the fire alarm, and the nearest fire escape.
3. The safety of all people in the vicinity of a fire is of foremost importance. But do not endanger yourself!
4. In the event of a fire in your work area shout "*Fire!*" and pull the nearest fire alarm.
5. Do not attempt to extinguish a fire unless you are confident it can be done in a prompt and safe manner utilizing a hand-held fire extinguisher. Use the appropriate fire extinguisher for the specific type of fire. Most labs are equipped with Class A, B, and C extinguishers. Do not attempt to extinguish Class D fires which involve combustible metals such as magnesium, titanium, sodium, potassium, zirconium, lithium, and any other finely divided metals which are oxidizable. Use a fire sand bucket for Class D fires.
6. Do not attempt to fight a major fire on your own.
7. If possible, make sure the room is evacuated; close but do not lock the door and safely exit the building.

Clothing on Fire

Do not use a fire extinguisher on people

1. Douse with water from safety shower immediately or
2. Roll on floor and scream for help or
3. Wrap with fire blanket to smother flame (a coat or other nonflammable fiber may be used if blanket is unavailable). Do not wrap a standing person; rather, lay the victim down to extinguish the fire. The blanket should be removed once the fire is out to disperse the heat.

Equipment Failure or Hazard

Failure of equipment may be indicative of a safety hazard - You must report all incidents.

Should you observe excessive heat, excessive noise, damage, and/or abnormal behaviour of the lab equipment:

1. Immediately discontinue use of the equipment.
2. In power labs, press wall-mounted emergency shut-off button.
3. Inform your TA of the problem.
4. Wait for further instructions from your TA.
5. TA must file an incident report.

Protocol For Safe Laboratory Practice

In general, leave equipment in a safe state when you finish with it. When in doubt, consult the course TA.

Defined Roles

TA	The first point of contact for lab supervision	
ECE Lab Supervisor	Steve Spencer- ITB 147	steve@mail.ece.mcmaster.ca
ECE Chair	Shahram Shirani- ITB A111	shirani@mcmaster.ca
ECE Administrator	Shelby Gaudrault- ITB A111	gaudraus@mcmaster.ca
ECE Course Instructor	Please contact your specific course instructor directly	