

**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:**            Tuesday            11:30 - 12:20 pm  
                          Wednesday            1:30 - 2:20 pm  
                          Thursday            1:30 - 2:20 pm

**Tutorial:**            Friday            8:30 - 9:20 am

**Labs:**            Monday to Friday            Starts on Feb. 3  
                          (Every Other Week)

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

**INSTRUCTOR**

Dr. Mahmoud Maghrabi

E-mail: maghrabm@mcmaster.ca

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/S

The Course Management System will be **Avenue to Learn**. The student is required to **check the system daily** 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 the knowledge of circuit analysis and fundamental of electromagnetics.

#### COURSE MATERIALS

##### Required Texts:

- Textbook: "[Electric Machinery Fundamentals](#)" by Stephen J. Chapman, McGraw--Hill, 5<sup>th</sup> 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, 1<sup>st</sup> Edition, PWS Pub. Co., ISBN: 0- 534-95222-4, 2000.
- "*Electric Motor Drives: Modeling, Analysis, and Control*", By: R. Krishnan, 1<sup>st</sup> 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	Course Introduction	Chapman: 1.1, 1.9, Appendix A
3 - 4	Introduction to 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 time line is available on the course website.

At certain points in the course, it may make good sense to modify the schedule. The instructor may modify elements of the course and will notify students accordingly (in class, on the course website).

## LABORATORY OVERVIEW

**Labs are NOT held during the first week of term.**

Lab	Topic
1	Three-phase Systems
2	Transformers
3	Synchronous Generators
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. Information on accessing and using the lab can be found on this webpage: <https://www.eng.mcmaster.ca/ece/labs-and-health-safety#Labs-Access-and-Use>
- Please obtain your own Access Card for use during regular building hours / The TA will open the lab at regularly scheduled lab times.
- The labs for this course will be held in ITB-AB110.
- The labs will be performed in groups of two or three students.
- The TAs and the instructor reserve the right to interview students to assess their understanding of the lab material. Such interviews will be held at random and we reserve the right to adjust the lab mark based on the outcome of the interview.
- Lab Requirements: Students need to submit their experiment results on Avenue to Learn on the due date described in the lab manual. No late submission will be accepted.

**ASSESSMENT**

**Course Evaluation:**

Components	Weight
Lab Evaluation (four labs)	16%
Midterm Exam (two one-hour exams)	34%
Final Exam (2.5 hours, scheduled and supervised by the registrar)	50%
<b>Total</b>	<b>100%</b>

**Grading and Evaluation Policies:**

- There are four (4) laboratories, two (2) midterm test, and one (1) final exam to be evaluated in this course.
- No make-up/deferred midterm test. With a faculty-approved MSAF filed, the weight of the missed midterm test is transferred to the final exam.

**Note:**

The instructor(s) reserves the right to choose the format (i.e. written or oral) of any deferred midterm or exam in this course. Please note that announcements concerning any type of graded material may be in any format (e.g., announcements may be made only in class). Students are responsible for completing the graded material regardless of whether they received the announcement or not.

**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](http://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](mailto: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](http://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

ITB A111, 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	<a href="mailto:steve@mail.ece.mcmaster.ca">steve@mail.ece.mcmaster.ca</a>
ECE Chair	Mohamed Bakr- ITB A111	<a href="mailto:mbakr@mcmaster.ca">mbakr@mcmaster.ca</a>
ECE Administrator	Shelby Gaudrault- ITB A111	<a href="mailto:gaudraus@mcmaster.ca">gaudraus@mcmaster.ca</a>
ECE Course Instructor	Please contact your specific course instructor directly	