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 and AC generators and motors.

PRE-REQUISITES AND ANTI-REQUISITES

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

SCHEDULE

Lectures: Monday 1:30 - 2:20 pm MDCL 1105
       Wednesday 1:30 - 2:20 pm MDCL 1105
       Thursday 1:30 - 2:20 pm MDCL 1105

Tutorial: Friday 10:30 - 11:20 am ITB 137

Labs: Monday to Friday Starts on Jan. 30 ITB AB110

L01 Mondays 2:30 pm – 5:20 pm L02 Mondays 6:30 pm – 9:20 pm
L03 Tuesdays 2:30 pm – 5:20 pm L04 Tuesdays 6:30 pm – 9:20 pm
L05 Wednesdays 2:30 pm – 5:20 pm L06 Wednesdays 6:30 pm – 9:20 pm
L07 Thursdays 2:30 pm – 5:20 pm L08 Thursdays 6:30 pm – 9:20 pm
L09 Fridays 2:30 pm – 5:20 pm L10 Fridays 6:30 pm – 9:20 pm

INSTRUCTOR

Dr. Mahmoud Maghrabi
Email: maghrabm@mcmaster.ca
Office:
Office Hours: By appointment – Please 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 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.

ASSUMED KNOWLEDGE

It is assumed that the students have the knowledge of circuit analysis and fundamental of electromagnetics.

COURSE MATERIAL

Required Text:


Optional Texts (these are the course references):

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

COURSE OVERVIEW

At certain points in the course it may make good sense to modify the schedule outlined below. The instructor reserves the right to modify elements of the course and will notify students accordingly (in class and post any changes to the course website).

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 2</td>
<td>Course Introduction</td>
</tr>
<tr>
<td>3 - 4</td>
<td>Introduction to Energy Conversion</td>
</tr>
<tr>
<td>5 - 6</td>
<td>Transformers</td>
</tr>
<tr>
<td>7</td>
<td>Fundamentals of AC machines</td>
</tr>
<tr>
<td>8 - 9</td>
<td>Synchronous Generators</td>
</tr>
<tr>
<td>10 - 12</td>
<td>Induction Motors</td>
</tr>
<tr>
<td>12</td>
<td>Other machines</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Topic</th>
<th>Number of Sessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Course Introduction</td>
<td>6</td>
</tr>
<tr>
<td>2. Introduction to Energy Conversion</td>
<td>6</td>
</tr>
<tr>
<td>3. Transformers</td>
<td>6</td>
</tr>
<tr>
<td>4. Fundamentals of AC machines</td>
<td>3</td>
</tr>
<tr>
<td>5. Synchronous Generators</td>
<td>6</td>
</tr>
<tr>
<td>6. Induction Motors</td>
<td>7</td>
</tr>
<tr>
<td>7. Other machines</td>
<td>2</td>
</tr>
<tr>
<td>Total sessions</td>
<td>36</td>
</tr>
</tbody>
</table>

LABORATORY OVERVIEW

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Three-phase Systems</td>
</tr>
<tr>
<td>7</td>
<td>Transformers</td>
</tr>
<tr>
<td>9</td>
<td>Synchronous Generators</td>
</tr>
<tr>
<td>11</td>
<td>Induction Motors</td>
</tr>
</tbody>
</table>
LABORATORY OPERATION

- "Each student in the course is required to pass the lab safety quiz prior to attempting any of the laboratories. The video and quiz will be 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 the 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.

ASSESSMENT

Course Evaluation:

<table>
<thead>
<tr>
<th>Components</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab Evaluation (four labs)</td>
<td>16%</td>
</tr>
<tr>
<td>Midterm Exam (two one-hour exams)</td>
<td>34%</td>
</tr>
<tr>
<td>Final Exam (3 hours, scheduled and supervised by the registrar)</td>
<td>50%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
</tr>
</tbody>
</table>

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-procedures-guidelines/

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.

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.

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.

ACCREDITATION LEARNING OUTCOMES

Note: The Learning Outcomes 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.

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Indicators</th>
<th>Measurement Method(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demonstrate ability to select appropriate numerical methods when solving a certain type of problems.</td>
<td>2.2</td>
<td>exam</td>
</tr>
<tr>
<td>Able to recognize and discuss applicable theory knowledge base</td>
<td>3.1</td>
<td>exam</td>
</tr>
<tr>
<td>Capable of selecting appropriate model and methods and identify assumptions and constraints</td>
<td>3.2</td>
<td>exam</td>
</tr>
<tr>
<td>Include appropriate health and safety considerations</td>
<td>4.5</td>
<td>exam</td>
</tr>
<tr>
<td>Determines and employs applicable standards and codes of practice.</td>
<td>4.6</td>
<td>exam</td>
</tr>
</tbody>
</table>

ON-LINE STATEMENT FOR COURSES REQUIRING ONLINE ACCESS OR WORK

In this course, we will be using Avenue to Learn (http://avenue.mcmaster.ca/). Students should be aware that, when they access the electronic components of this course, 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 this course will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor.

NOTICE REGARDING POSSIBLE COURSE MODIFICATION

The instructor and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes.
www.eng.mcmaster.ca/ece
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.

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
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

<table>
<thead>
<tr>
<th>Role</th>
<th>Contact Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA</td>
<td>The first point of contact for lab supervision</td>
</tr>
<tr>
<td>ECE Lab Supervisor</td>
<td>Steve Spencer- ITB 147 <a href="mailto:steve@mail.ece.mcmaster.ca">steve@mail.ece.mcmaster.ca</a></td>
</tr>
<tr>
<td>ECE Chair</td>
<td>Mohamed Bakr- ITB A111 <a href="mailto:mbakr@mcmaster.ca">mbakr@mcmaster.ca</a></td>
</tr>
<tr>
<td>ECE Administrator</td>
<td>Shelby Gaudrault- ITB A111 <a href="mailto:gaudraus@mcmaster.ca">gaudraus@mcmaster.ca</a></td>
</tr>
<tr>
<td>ECE Course Instructor</td>
<td>Please contact your specific course instructor directly</td>
</tr>
</tbody>
</table>