Course Outline

ELEC ENG 4PK4
Fall/Winter 2017/2018

ELEC ENG 4PK4 C01
Power Electronics
Winter 2018
Course Outline

CALENDAR/COURSE DESCRIPTION

To analyze, model, and predict the performance of basic power converter configurations. To explain topologies of power electronics, AC/DC, DC/DC, DC/AC and AC/AC. To design proper switching circuits.

PRE-REQUISITES AND ANTI-REQUISITES

Prerequisite(s): ELECENG 2CJ4, ELECENG 3EJ4

SCHEDULE

Lectures: Monday, Wednesday, Thursday 10:30 am – 11:20am (BSB 137)
Tutorial: Thursday 11:30 am – 12:20pm (BSB 137)
Labs: Every Other Week: L01 Monday 2:30 pm – 5:20 pm; L02 Monday 2:30 pm – 5:20 pm; L03 Tuesday 2:30 pm – 5:20 pm; L04 Tuesday 2:30 pm – 5:20 pm; L05 Wednesday 2:30 pm – 5:20 pm; L06 Wednesday 2:30 pm – 5:20 pm; L07 Thursday 2:30 pm – 5:20 pm; L08 Thursday 2:30 pm – 5:20 pm; L09 Friday 2:30 pm – 5:20 pm; L10 Friday 2:30 pm – 5:20 pm

INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

Dr. Jennifer Bauman
ITB A217
jennifer.bauman@mcmaster.ca

Office Hours:
Wednesdays 12pm to 2pm
Or by appointment

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

John Reimers
reimerja@mcmaster.ca
Office hours: TBD

Hosnee Mobarek
mobarm2@mcmaster.ca
Office hours: TBD

Nishant Kashyap
kashyan@mcmaster.ca
Office hours: TBD

COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION

Course instructions and lecture material will be posted via Avenue to Learn, the McMaster University electronic learning system, accessible at http://avenue.mcmaster.ca.
COURSE OBJECTIVES

Power electronic converters are used in different applications that range from low-power phone/laptop battery chargers, home appliances, and automotive systems; to medium-power renewable energy systems, switching power supplies, and industrial motor drives, to high-power active filters and high voltage AC transmission systems for power systems.

By the end of this course, the student will be able to:

1. Define power electronics and recognize power electronic devices, circuits, and applications.
2. Classify converter types and conversion functions.
3. Recognize converter topologies, derive their governing equations, and design, analyse and simulate converter circuits.
4. Draw I-V characteristics of power devices and analyse their switching behaviour.
5. Interpret power device datasheets and use the appropriate parameters in design, analysis and simulation.

ASSUMED KNOWLEDGE

Students should have knowledge of following topics:

1. Circuits Analysis and Systems
2. Electronic Devices

COURSE MATERIALS

Required Texts:


Calculator: The only calculator permitted in tests and examinations is the McMaster Standard Calculator (Casio FX 991MS or MS Plus).
# COURSE OVERVIEW

<table>
<thead>
<tr>
<th>Date/Week</th>
<th>Topic</th>
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</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>Introduction to Power Electronics, Review of Electric Circuits</td>
</tr>
<tr>
<td>Week 2</td>
<td>Power Semiconductor Devices</td>
</tr>
<tr>
<td>Week 3</td>
<td>Non-Ideal Devices</td>
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<tr>
<td>Week 4</td>
<td>AC -&gt; Uncontrolled DC: Diode Rectifiers</td>
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<tr>
<td>Week 5</td>
<td>AC -&gt; Controlled DC: Phase-Controlled Rectifiers and Inverters</td>
</tr>
<tr>
<td>Week 6</td>
<td>DC -&gt; DC: Non-Isolated DC/DC Converters (Buck)</td>
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<tr>
<td>Week 7</td>
<td>DC -&gt; DC: Non-Isolated DC/DC Converters (Boost)</td>
</tr>
<tr>
<td>Week 8</td>
<td>DC -&gt; DC: Non-Isolated DC/DC Converters (Buck-Boost)</td>
</tr>
<tr>
<td>Week 9</td>
<td>DC -&gt; DC: Isolated DC/DC Converters</td>
</tr>
<tr>
<td>Week 10</td>
<td>DC -&gt; AC: Single Phase Inverters</td>
</tr>
<tr>
<td>Week 11</td>
<td>DC-&gt; AC: Three Phase Inverters</td>
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<tr>
<td>Week 12</td>
<td>Review</td>
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</tbody>
</table>

# LABORATORY OVERVIEW

<table>
<thead>
<tr>
<th>Date/Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab 1</td>
<td>Diode Rectifiers</td>
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<tr>
<td>Lab 2</td>
<td>Thyristor Converter</td>
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<tr>
<td>Lab 3</td>
<td>Simulation of Buck Converter</td>
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<tr>
<td>Lab 4</td>
<td>Simulation of Boost Converter</td>
</tr>
<tr>
<td>Lab 5</td>
<td>AC/AC Converter</td>
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</tbody>
</table>

# LABORATORY OPERATION

All students are expected to complete and pass the ECE lab safety training prior to the first laboratory. The lab training is available online at: [https://www.eng.mcmaster.ca/ece/labs-and-health-safety](https://www.eng.mcmaster.ca/ece/labs-and-health-safety)

# ASSESSMENT

<table>
<thead>
<tr>
<th>Component</th>
<th>If Final Exam Mark &gt;= 50%</th>
<th>If Final Exam Mark &lt; 50%</th>
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<tbody>
<tr>
<td></td>
<td>Weight</td>
<td>Weight*</td>
</tr>
<tr>
<td>Labs (5 x 5%)</td>
<td>25%</td>
<td>0%</td>
</tr>
<tr>
<td>Midterm</td>
<td>25%</td>
<td>0%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>50%</td>
<td>100%</td>
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<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
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* In order to pass the class, you must pass the final exam.
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 Methods(s)</th>
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</thead>
<tbody>
<tr>
<td>Recognize converter topologies, derive their governing equations</td>
<td>2.3</td>
<td>Exams</td>
</tr>
<tr>
<td></td>
<td>3.3</td>
<td></td>
</tr>
<tr>
<td>Design, analyse and simulate converter circuits</td>
<td></td>
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</tr>
<tr>
<td>Simulate and test the fundamental power electronic topologies in a laboratory setup</td>
<td>4.1</td>
<td>Labs</td>
</tr>
<tr>
<td>Interpret power device datasheets and use the appropriate parameters in design, analysis and simulation</td>
<td>4.1</td>
<td>Exams</td>
</tr>
<tr>
<td>Analysis of non-sinusoidal circuits</td>
<td>2.3</td>
<td>Exams</td>
</tr>
<tr>
<td></td>
<td>3.3</td>
<td></td>
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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. 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. It is your responsibility to understand what constitutes academic dishonesty. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at http://www.mcmaster.ca/academicintegrity.

The following illustrates only three forms of academic dishonesty:

1. Plagiarism, e.g. the submission of work that is not one’s own or for which other credit has been obtained.
2. Improper collaboration in group work.
3. Copying or using unauthorized aids in tests and examinations.
ACADEMIC ACCOMMODATIONS

Students who require academic accommodation must contact Student Accessibility Services (SAS) to make arrangements with a Program Coordinator. Academic accommodations must be arranged for each term of study. Student Accessibility Services can be contacted by phone at 905.525.9140 ext. 28652 or e-mail at sas@mcmaster.ca. For further information, consult McMaster University’s Policy for Academic Accommodation of Students with Disabilities.

NOTIFICATION OF STUDENT ABSENCE AND SUBMISSION OF REQUEST FOR RELIEF FOR MISSED ACADEMIC WORK

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":
http://www.mcmaster.ca/msaf/

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.

REFERENCE TO RESEARCH ETHICS

The two principles underlying integrity in research in a university setting are these: a researcher must be honest in proposing, seeking support for, conducting, and reporting research; a researcher must respect the rights of others in these activities. Any departure from these principles will diminish the integrity of the research enterprise. This policy applies to all those conducting research at or under the aegis of McMaster University. It is incumbent upon all members of the university community to practice and to promote ethical behaviour. To see the Policy on Research Ethics at McMaster University, please go to
Information for Laboratory Safety and Important Contacts

This document is for users of ECE instructional laboratories in the Information Technology Building.

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.

General Health and Safety Principles
Good laboratory practice requires that every laboratory worker and supervisor observe the following:
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
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

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**In Case of a Fire (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 Lab, 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
Leave equipment in a safe state for the next person - if you’re not sure, ask!
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 Information</th>
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<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>Tim Davidson - ITB A111 <a href="mailto:davidson@mcmaster.ca">davidson@mcmaster.ca</a></td>
</tr>
<tr>
<td>ECE Administrator</td>
<td>Kerri Hastings - ITB A111 <a href="mailto:hastings@mcmaster.ca">hastings@mcmaster.ca</a></td>
</tr>
<tr>
<td>ECE Course Instructor</td>
<td>Please contact your specific course instructor directly</td>
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