

Department of Electronics
Carleton University

ELEC 3508: Power Electronics
Fall 2020

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Course Objectives:

Power electronics is the application of solid-state electronics to the control and conversion of electric power. It also refers to a subject of research in electronic and electrical engineering which deals with the design, control, computation and integration of nonlinear, time-varying energy-processing electronic systems with fast dynamics (Wikipedia). This course covers the following contents:

- Introduction to power semiconductor devices (thyristors, GTOs, IGBTs)
- Theory and operation of converter circuits (controlled AC to DC rectifiers, choppers, DC to AC inverters, AC voltage controllers)
- Overview of applications of conversion circuits (motor drives, FACTS, distributed generation)

The main objectives of the course are:

- (1) to help students gain a thorough understanding of the basic concepts and techniques of power electronics devices;
- (2) to provide students with the fundamental knowledge necessary to design power converter circuits;
- (3) to enable students to acquire hands-on experience on control and operation of power converters;
- (4) to give student opportunities to learn industrial cases (power electronics industry) and to interact with professionals from industry;
- (5) to train students to independently and collaboratively conduct research and present research results.

By the end of the course students should be able to:

- (1) explain principles of the focused power converter circuits, i.e., DC/DC, AC/DC, and DC/AC converters;
- (2) analyze switching waveforms of the focused power converters and calculate steady-state voltage, current, power, and other related factors of the converter waveforms;
- (3) understand the application theory of power electronics converters in industry;

- (4) review literature, identify questions, discuss solutions, and present results in the research area of power electronics.

Course Schedule:

Lecture: 10:05 am - 11:25 am, Tuesday and Thursday, online

Laboratories: Canal Building (CB) (remote labs)

Monday A1 2:35 pm - 5:25 pm in CB 3104

Wednesday A2 2:35 pm - 5:25 pm in CB 3104

Friday A3 2:35 pm - 5:25 am in CB 3104

(Tentative schedule)	PA/Lab	PA/Lab	PA/Lab	Lecture	Lecture
	Monday (A3)	Thursday (A1)	Wednesday (A2)	Tuesday (Lecture No)	Thursday (Lecture No)
Week 1	N/A	N/A	N/A		0
Week 2	N/A	N/A	N/A	1	2
Week 3	Lab demo	Lab demo	Lab demo	3	4
Week 4	N/A	N/A	N/A	5	6 (Midterm 1)
Week 5	Lab 1	Lab 1	Lab 1	7	8
Week 6	N/A	N/A	N/A	9	10
Week 7	Lab 2	Lab 2	Lab 2	11	12
Week 8	Fall Break				
Week 9	N/A	N/A	N/A	13	14
Week 10	Lab 3	Lab 3	Lab 3	15	16 (Midterm 2)
Week 11	Lab 4	Lab 4	Lab 4	17	18
Week 12	N/A	N/A	N/A	19	20
Week 13	Lab 5	Lab 5	Lab 5	21	22
Week 14	Lab 6	Lab 6	Lab 6	23	24

Course Textbook:

Mohan, Undeland and Robbins, "Power Electronics, Converters, Applications and Design," Third Edition, ISBN 978-0-471-22693-2

Prerequisite(s): ELEC 2501 (Circuits and Signals) and ELEC 2507 (Electronics I)

CULearn:

CULearn will be used for communication and posting of course material, including lecture slides. The CULearn site can be accessed from <https://www.carleton.ca/culearn/>. Please refer to the CULearn site frequently in order to keep up-to-date with the course material that is posted there.

Marking Scheme:

Final exam	50%	(open book)
1/3 term exam	10%	(open book)
2/3 term exam	10%	(open book)
Labs reports	30%	

Note:

1. The final exam is for evaluation purposes only and will not be returned to students. Textbook and lecture slides can be brought into the final exam and the midterm exams.
2. In the event that you miss the 1/3 term exam or the 2/3 term exam and have a valid reason, the equivalent of the term portion of the final grade will be shifted to the final exam. If you miss any of the term exams without a valid reason, you will receive a grade of 0 on the term exam(s) missed.
3. In addition to having a passing grade for the entire course, students must also have obtained a passing grade in the laboratory portion of the course as well.

Labs:

The objective of the labs is to gain hands on experience making measurements, recording and plotting data, not to write lengthy reports. Labs will be graded partly on the ability to demonstrate your experimental work to the TA, and partly on lab reports. Lab reports are normally due at the end of the laboratory period. Late labs are worth 0 and must still be handed in. In order to pass ELEC 3508, it is necessary to complete all 6 labs. If you miss a lab due to illness or other valid reason you must arrange a time to complete a make-up lab. All lab results are to be written directly in the space provided in the instruction sheets. A completed lab will include the introduction sheets, instruction sheets and any closing sheets. All is to be stapled together and handed to the TA at the end of the lab period. The TA will also sign you in at the start of the lab and sign you out at the end of the lab. No laboratory exemptions are given to students who are repeating the course. Each laboratory is worth 5% of your final grade. All laboratory pages are to be printed by the student from CULearn.

Lecture Topics: The list below indicates possible topics covered in the course.

Lecture 0: Introduction to power electronics and power systems

Lecture 1: Power switches, switching circuits

Lecture 2: Single-phase diode converters

Lecture 3: Three-phase diode converters

Lecture 4: Single-phase thyristor converters

Lecture 5: Three-phase thyristor converters

Lecture 6: Midterm Exam 1

Lecture 7: DC - DC converters, Buck converters

Lecture 8: Boost converters, Buck-boost converters

Lecture 9: Cuk converters, full bridge DC - DC converters

Lecture 10: Switch mode inverters

Lecture 11: Single-phase inverters

Lecture 12: Three-phase inverters

Fall break: no classes

Lecture 13: Resonant converters

Lecture 14: Guest Lecture 1

Lecture 15: Switching DC power supplies

Lecture 16: Midterm Exam 2

Lecture 17: Uninterruptable power supplies

Lecture 18: DC motors and DC motor drives

Lecture 19: Residential applications

Lecture 20: Static VARs compensation

Lecture 21: Interconnection of renewable energy sources and energy storage

Lecture 22: Induction motors and induction motor drives

Lecture 23: Synchronous motors and synchronous motor drives

Lecture 24: Guest Lecture 2

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 see the Student Guide

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 see the Student Guide

Academic Accommodations for Students with Disabilities: The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your Letter of Accommodation at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website for the deadline to request accommodations for the formally-scheduled exam (if applicable).

You can visit the Equity Services website to view the policies and to obtain more detailed information on academic accommodation at <http://www.carleton.ca/equity/>