Carleton University
Department of Electronics

Fall 2023

ELEC 3508 : Power Electronics

Course schedule:

Lecture Mon & Wed 10:05-11:25 Southam Hall 409

Lab A1 Fri 08:35-11:25, A2 Thu 08:35-11:25, A3 Fri 14:35-17:25 CB3104

Instructor: Hima Dhulipati, himadhulipati@cunet.carleton.ca

Teaching assistant: TBD

Course description:

Calendar description - *Power semiconductor devices: Thyristor, GTO, IGBT, SiC, GaN. Converter circuits: controlled AC to DC rectifiers, choppers, DC to AC inverters, AC voltage controllers. Protection of conversion circuits. Applications to high-efficiency control of electric machines and electromechanical energy conversion devices.*

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, 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)

(5) to train students to independently and collaboratively conduct research and present research results.

Labs: Labs are intended to provide practical experience in working with power electronics. Labs typically require design of simple circuits, measurements, and analysis.

Lab instructions will be available on the course web page during the term.

Some labs require circuit simulation using MATLAB Simulink (posted as assignments) with results verified by experimental measurements.

Health and Safety: Respecting lab safety precautions and following directions of lab staff is essential to keep everyone safe.

It is important to remember that COVID is still present in Ottawa. The situation can change at any time and the risks of new variants and outbreaks are very real. There are a number of actions you can take to lower your risk and the risk you pose to those around you including being vaccinated, wearing a mask, staying home when you're sick, washing your hands and maintaining proper respiratory and cough etiquette.

General lab safety precautions are still important and can be found at https://carleton.ca/ehs/programs/working-lab/laboratory-health-and-safety/

Outcomes: On successful completion of the course, a student is expected to be able:

- Explain principles of the focused power converter circuits, i.e., DC/DC, AC/DC, and DC/AC converters;
- Analyze switching waveforms of the focused power converters and calculate steady-state voltage, current, power, and other related factors of the converter waveforms;
- Understand the application theory of power electronics converters in industry;
- Review literature, identify questions, discuss solutions, and present results in the research area of power electronics.

Precluded courses: none

Prerequisites: ELEC2507 and ELEC2602.

Accreditation units: Accreditation units (AU's) are used by the Canadian Engineering Accreditation Board (CEAB) to determine if an Engineering program meets a minimum number of class hours required for accreditation in each of 5 components: math, natural science, engineering science, engineering design, and complementary studies. Accreditation metrics are based on courses common to all students in a program.

Math	Natural Science	Complementary Studies	Engineering Science	Engineering Design
			100%	

Learning Outcomes:
At the end of the course (or program), the successful student will know and be able to:

1. Apply the knowledge of power diodes, thyristors, IGBTs, rectifiers, inverters, etc. gained during the lectures to the design of a battery charging system or a motor drive for electric vehicle applications.
2. Overcome practical hurdles including the construction of a PWM driver board and the testing of components in a practical inverter by supplementing textbook knowledge with self-found materials.
3. Use Matlab/Simulink environment to validate concepts learned in lectures and tutorials. Extend these skills to predict component stresses and select properly sized components for practical designs.
4. Write technical reports detailing their involvement in the design of their systems. Display their analysis in a logical manner that demonstrates their methodology clearly.
5. Work on real projects that which reflect the direction of society towards green energy solutions including power electronics converter based charging and drives for electric vehicles.
6. Share the requirements and output of their subsystem with their group members to work towards a completed and functioning system.
7. Work in teams towards completion of an experiment, with individual and group objectives.
8. Follow their own self-directed solution path to design and develop specific systems in their assigned projects.

Graduate attributes: The Canadian Engineering Accreditation Board requires graduates of undergraduate engineering programs to possess 12 attributes: Graduate-Attributes.pdf (engineerscanada.ca) or GA's. Courses in all four years of our programs evaluate students' progress towards acquiring these attributes. Aggregate data (typically, the data collected in all sections of a course during an academic year) is used for accreditation purposes and to guide improvements to programs. Some of the assessments used to measure GAs may also contribute to final grades; however, the GA measurements for individual students are not used to determine the student's year-to-year progression through the program or eligibility to graduate.

Accreditation metrics are based on courses common to all students in a program.

This following list provides the GAs that will be measured in this course, along with the learning outcomes that are intended to develop abilities related to these attributes.

GA - Indicator	Course Learning Outcomes (from the list above)
2. Problem analysis *An ability to use appropriate knowledge and skills to identify, formulate, analyze, and solve complex engineering problems in order to reach substantiated conclusions.*	1,2,3,7,8
4. Design *An ability to design solutions for complex, open-ended engineering problems and to design systems, components or processes that meet specified needs with appropriate attention to health and safety risks, applicable standards, economic, environmental, cultural and societal considerations.*	2,4,5,6,8

Textbooks:

Power Electronics *by Mohan, Undeland and Robins, 3rd Edition, 2003, John Wiley & Sons, Inc. ISBN 978-0-471-22693-2*
Lab and Tutorial Manuals *by H. Dhulipati*
IEEE Xplore
University Library

Evaluation :

Method of Evaluation	% of Final Grade
Assignments/Lab Experiments	25
Midterm exam (closed-book), Nov. 1, 2023	20
Final exam (closed-book)	50
Participation	5

Additional requirements - Satisfactory performance during the term requires completion of all lab experiments and a combined average grade of >40% on lab reports and assignments.

Final Examination -The final exam is for evaluation purposes only and will not be returned to the student.

Students who are unable to write the final examination due to serious illness, emergency or other circumstances beyond their control may apply for accommodation by contact the Registrar's office. Consult Section 4.3 of the University Calendar.

Missed term work - Students who claim illness, injury or other extraordinary circumstances beyond their control as a reason for missed term work are held responsible for immediately informing the instructor concerned and for making alternate arrangements with the instructor. In all cases this must occur no later than three (3) days after the term work was due. The alternate arrangement must be made before the last day of classes in the term as published in the academic schedule. Consult Section 4.4 of the University Calendar.

Generative Artificial Intelligence (AI): Use of generative AI tools (such as ChatGPT) in course work is prohibited unless explicitly authorized by the course instructor for specific elements of the course. Submission of AI generated work without authorization may lead to an academic integrity investigation.

Other Electronic Devices Aside from Calculators: Electronic devices aside from calculators are NOT permitted during tests/exams.

Acceptable use of technology during class: The use of technology during lectures and tutorials is limited to resources associated with this course, such as lecture notes and property data information. Social media and general web surfing are never acceptable uses of technology during class; additionally, you distract the students around you. If a situation arises where you need to communicate by e-mail or cell phone, please respect your fellow students and leave the classroom to attend to the matter. You may return to class when the matter is resolved.

Academic integrity and plagiarism

a) Please consult the Faculty of Engineering and Design information page about the Academic Integrity policy and our procedures: https://carleton.ca/engineering-design/current-students/fed-academic-integrity
Violations of the Academic Integrity Policy will result in the assignment of a penalty such as reduced grades, the assignment of an F in a course, a suspension or, expulsion.

b) One of the main objectives of the Academic Integrity Policy is to ensure that the work you submit is your own. As a result, it is important to write your own solutions when studying and preparing with other students and to avoid plagiarism in your submissions. The University Academic Integrity Policy defines plagiarism as “presenting, whether intentionally or not, the ideas, expression of ideas or work of others as one’s own.” This includes reproducing or paraphrasing portions of someone else’s published or unpublished material, regardless of the source, and presenting these as one’s own without proper citation or reference to the original source.
Examples of violations of the policy include, but are not limited to:

- any submission prepared in whole or in part, by someone else;
- using another’s data or research findings without appropriate acknowledgement;
- submitting a computer program developed in whole or in part by someone else, with or without modifications, as one’s own; and
- failing to acknowledge sources of information through the use of proper citations when using another’s work and/or failing to use quotation marks.

Advising and Counselling services

a) Engineering Academic Advising

The Engineering Academic Support Service : https://carleton.ca/engineering-design/current-students/undergrad-academic-support/ assists undergraduate engineering students with course selection, registration, and learning support from first-year through to graduation.
Academic advisors contact information: https://carleton.ca/engineering-design/current-students/undergrad-academic-support/undergraduate-advisors/

b) Student Mental Health Service

As a University student you may experience a range of mental health challenges that significantly impact your academic success and overall well-being. Carleton's Wellness Services Navigator https://wellness.carleton.ca/navigator/ is designed to help students connect with mental health and wellness resources. If you need to talk to someone, please reach out for assistance: https://carleton.ca/health/emergencies-and-crisis/.

Learning and working environment

The University and all members of the University community share responsibility for ensuring that the University's educational, work and living environments are free from discrimination and harassment. Should you have concerns about harassment or discrimination relating to your age, ancestry, citizenship, colour, creed (religion), disability, ethnic origin, family status, gender expression, gender identity, marital status, place of origin, race, sex (including pregnancy), or sexual orientation, please contact the Department of Equity and Inclusive Communities at equity@carleton.ca
We strive to create an environment of mutual respect for all through equity, diversity, and inclusion within this course. The space which we work in will be safe for everyone. Please be considerate of everyone's personal beliefs, choices, and opinions.

Academic Accommodation

Academic accommodation refers to educational practices, systems and support mechanisms designed to accommodate diversity and difference. At no time should academic accommodation undermine or compromise the learning objectives that are established by the academic authorities of the University.

a) **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 initiate a 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 the instructor to ensure accommodation arrangements are made. Please consult the PMC website for the deadline to request accommodations for the formally-scheduled exam (if applicable).

b) **Accommodation for Student Activities:** Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation will be provided to students who compete or perform at the national or international level. Contact the instructor 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. https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf

c) **Pregnancy obligation**: contact the instructor 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 accommodation regarding a formally-scheduled final exam, you must complete the Pregnancy Accommodation Form.

d) **Religious obligation**: contact the instructor 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.

e) **Survivors of Sexual Violence:** As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit: https://carleton.ca/equity/sexual-assault-support-services