Western Engineering

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEEING

ECE 4457a – Power Electronics

Course Outline Fall/Winter 2025-2026

COURSE DESCRIPTION: Power electronics is the branch of electrical engineering that is related to the use of power semiconductor devices to convert the power that is available from a source to the form that is required by a load or loads. Power converters are essentially electrical interfaces between sources and loads and can be found in almost all electrical and electronic equipment as it is rare for power sources to be electrically compatible with loads. Typical power electronic applications include renewable energy systems, interfaces for grid-connected power systems and microgrids, electric vehicles, commercial power supplies, motor drives, consumer electronics, and lighting. The objective of the course is to familiarize the student with a number of fundamental power electronic converter topologies (circuit structures) and their application, and to provide the student with a firm grasp of the essential principles of this field.

ACADEMIC CALENDAR: The use of power semiconductor devices in converter structures (topologies) to process and control the flow of electric energy. The aim of the course is to familiarize students with various power electronic converter topologies and their applications.

PRE OR COREQUISITES: ECE 2233A/B and ECE 3333A/B. Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you will be removed from this course and it will be deleted from your record.

ANTIREQUISITES: None

CEAB ACADEMIC UNITS: Engineering Science 100%

CONTACT HOURS:

Lectures and tutorials occur weekly will be informed when a lab session will take place at least one week in advance.

LECTURE:	3 hours/week
LAB:	(3 hrs /4 times during the term)
TUTORIAL:	1 hour/week

RECOMMENDED TEXT: Daniel Hart, Power Electronics, McGraw Hill, 2010, ISBN 0-073-380679

This will be supplemented with additional lecture material, lab material and material given to students or posted on the course web site on the course OWL site.

RECOMMENDED SOFTWARE: An understanding of the various power electronic converter topologies and principles that will be covered in the course can be enhanced with the use of power electronic simulation software such as PSIM. A demo version of PSIM can be found at https://altair.com/psim.

RECOMMENDED RESOURCES/REFERENCES: N. Mohan, T. M. Undeland, and W. P. Robbins, Power Electronics: Converters, Applications, and Design, 3rd edition, John Wiley & Sons, 2003, ISBN 047122693. (As a general alternative to the Hart textbook).

G. Moschopoulos, DC-DC Converter Topologies: Basic to Advanced, John Wiley & Sons, 2024, ISBN 9781119612421. (As a supplement to the DC-DC converter material covered in this course.)

GENERAL LEARNING OBJECTIVES (CEAB GRADUATE ATTRIBUTES)

Knowledge Base	A	Engineering Tools	A	Impact on Society	
Problem Analysis	A	Individual & Team Work		Ethics and Equity	
Investigation	**A**	Communication		Economics and Project Management	
Design		Professionalism		Life-Long Learning	

Notation: x represents the content level code as defined by the CEAB. blank = not applicable; I = introduced (introductory); D = developed (intermediate) and A = applied (advanced).

Rating: I – The instructor will introduce the topic at the level required. It is not necessary for the student to have seen the material before. D – There may be a reminder or review, but the student is expected to have seen and been tested on the material before taking the course. A – It is expected that the student can apply the knowledge without prompting (e. g. no review).

COURSE MATERIALS: The material for this course will be taught in lectures, labs, and tutorials. Additional course content and the guides for the laboratories will be available on the course OWL site.

UNITS: SI

COURSE TOPICS AND SPECIFIC LEARNING OUTCOMES: This course is intended to be an introductory course in power electronics. No prior knowledge of the field is assumed, although prior knowledge of certain electrical engineering principles as taught in the prerequisite courses is required. After taking the course, students will gain knowledge of certain fundamental power electronic topologies and mathematical analysis methods that will enable them to understand basic power electronic considerations in their future careers, if necessary, after graduation.

The following table summarizes the course learning outcomes along with CEAB GAIs where the GAIs in bold indicate ones to be measured and reported annually.

Topics and Specific Learning Objectives	CEAB Graduate Attributes Indicators
1. Review of basic electrical and mathematical concepts related to power electronics At the end of this section, students will be able to: **a.** Understand mathematical concepts such as the averaging of waveforms, harmonics and their effect on power, root-mean-square, various definitions of power, power calculations of non-sinusoidal waveforms and perform analysis that is related to these concepts.	KB 4, PA 3
2. Uncontrolled line-commutated diode rectifiers At the end of this section, students will be able to: **a.** Understand the operation of single-phase and three-phase uncontrolled line-commutated diode rectifiers **b.** Perform analysis and solve problems related to the operation of single-phase an three-phase uncontrolled line-commutated diode rectifiers **c.** Understand the design of more sophisticated uncontrolled line-commutated diode rectifiers **d.** Perform experiments on uncontrolled line-commutated diode rectifiers with appropriate measurement tools and analyze the results.	KB 4 PA 3, **I 3** KB 4 PA 3, **I 3**, ET 2
3. Line-frequency phase-controlled rectifiers At the end of this section, students will be able to: **a.** Understand the operation of single-phase and three-phase line-frequency phase-controlled rectifiers and inverters.	KB 4

b. Perform analysis and solve problems related to the operation of single-phase and three-phase line-frequency phase-controlled rectifiers and inverters.	PA 3, **I 3**
c. Understand the design of single-phase and three-phase line-frequency phase-controlled rectifiers	KB 4
d. Perform experiments on single-phase and three-phase line frequency phase-controlled rectifiers with appropriate measurement tools and analyze the results.	PA 3, **I 3**, ET 2
4. Dc-ac switch-mode inverters At the end of this section, students will be able to:	
a. Understand the operation of single-phase and three-phase dc-ac switch-mode inverters.	KB 4
b. Understand the principles behind pulse-width modulation methods for single-phase and three-phase dc-ac switch mode inverters.	KB 4
c. Perform analysis and solve problems related to the operation of single-phase and three-phase dc-ac switch mode inverters.	PA 3, **I 3**
d. Understand the design of single-phase and three-phase inverters.	KB 4
e. Perform experiments on dc-dc switch-mode inverters with appropriate measurement tools and analyze the results.	PA 3, **I 3**, ET 2
5. Dc-dc switch-mode converters At the end of this section, students will be able to:	
a. Understand the operation of basic non-isolated dc-dc converters such as the buck, boost and buck-boost converters.	KB 4
b. Understand the operation of basic isolated dc-dc converters such as the flyback and forward converters.	KB 4
c. Perform analysis and solve problems related to the operation of non-isolated dc-dc converters.	PA 3

EVALUATION:

Name	% Worth	CEAB GAs ASSESSED
Labs (Total = 4)	15%	**I 3**
Mid-Term Examination	30%	KB 4, PA3
Final Examination	55%	KB4, PA3

Note that the dates of each assessment will be listed at least a week in advance on the course OWL site. Marks will be assigned on the basis of method of analysis and presentation, correctness of solution, clarity and neatness.

To obtain a passing grade in the course, a student must obtain a minimum of 50% for the final examination. A mark < 50% in final examination will result in a final course grade of 48% or less. This policy, however, may be overridden by the instructor under very rare and exceptional circumstances if numerous students do poorly on the final exam. A student can pass with a failing grade in the lab component but can only achieve a maximum grade of 50% for the course. Missing at least three labs for invalid and undocumented reasons will result in a course grade of 48% or less. A student can fail the midterm test and still pass the course. If a student does better in the final examination than on the midterm examination, then the final examination will count for 85% of the final grade.

All work submitted must be of professional quality in the requested format. Material that is handed in dirty, illegible, disorganized, or in an unapproved format will be returned to the student for resubmission and the late submission penalty will take effect. An additional penalty of 10% may be deducted for poor grammar, incoherence, or lack of flow in the written reports.

Homework Assignments: There will be no graded homework assignments in this course. Sets of practice problems will be posted up on the course OWL site during the semester.

COURSE POLICIES:

Laboratory: There will be 4 scheduled labs for the course. For each lab, students are expected to submit a lab report that will be due one week after completion of the lab, unless the instructor states that the due date is extended. Reports can be submitted to the assigned course locker on the second floor of the TEB building. If a student misses a lab and has a valid and documented reason for doing so, then the student will not be penalized. If a student has missed a lab and does

not have a valid and documented reason for doing so, then the student will receive a zero for the missing lab. There will be no make-up labs for individual students.

Students who arrive 30 min after the scheduled lab time without a legitimate reason, leave the lab early without permission from the teaching assistant, or miss the lab without a legitimate reason may receive a zero for the corresponding laboratory assignment. Students who miss a lab with academic consideration are required to contact the course instructor within 3 days for further instructions. Failure to do so will result in a zero mark for that lab.

The penalty for a late submission of a late lab report will be 20% per day. Late lab reports will not be accepted five days after a deadline. This policy, however, can be overridden if there is some sort of academic consideration, as defined below.

It should be noted that material related to the labs may be asked on any exam and students are responsible for this material regardless of lab attendance.

Midterm Test: A 2-hour midterm test will be held sometime around the end of October, early November in class. Students will be notified of the date and time of the midterm test at least one week in advance. Only the use of **non-programmable calculators** will be allowed for the mid-term test. **No other aids will be allowed.**

Final Examination: The final examination will be take place during the regular examination period. Only the use of **non-programmable calculators** will be allowed for the mid-term test. **No other aids will be allowed.**

LATE SUBMISSION POLICY:
Advise the instructor if you are having problems completing the assignment on time prior to the due date of the assignment and be prepared to submit an Academic Consideration Request and provide documentation if requested by the instructor at:

https://www.eng.uwo.ca/undergraduate/academic-consideration-for-absences.html

If you are granted an extension, establish a due date with the instructor. The approval of the Chair of your Department is not required if assignments are completed prior to the last day of classes. Extensions beyond the end of classes must have the consent of the instructor, the department Chair and the Associate Dean, Undergraduate Studies.

Documentation is mandatory.

ATTENDANCE: Attendance is mandatory for all labs. Although attendance is not mandatory for lectures and tutorials, students may be removed from a course after they have been warned if their attendance and course performance is deemed to be unsatisfactory by the instructor, unless a valid and documented reason is given.

ABSENCE FROM MANDATORY COURSE COMMITMENTS: Students must familiarize themselves with the Policy on **Academic Consideration for Absences:**
https://www.eng.uwo.ca/undergraduate/academic-consideration-for-absences.html

I. Missed/Late Accommodation Policy

1. Students missing a test/assignment/lab or examination you will report the absence by submitting Academic Consideration Request form through STUDENT ABSENCE PORTAL.
2. Documentation must be provided as soon as possible.
3. Forged notes and certificates will be dealt with severely. To submit a forged document is a scholastic offence.

II. Exam Accommodation

1. If you are unable to write a final examination, report your absence using the Academic Consideration Request Form through STUDENT ABSENCE PORTAL.
2. Be prepared to provide the Undergraduate Services Office with supporting documentation (see next page for information on documentation) the next day, or as soon as possible (in cases where students are hospitalized). **The following circumstances are not considered grounds for missing a final examination or requesting special examinations: common cold, headache, sleeping in, misreading timetable and travel arrangements.**
3. In order to receive permission to write a Special Examination, you must obtain the approval of the Chair of the Department and the Associate Dean and in order to apply you must submit an the Academic Consideration Request Form through STUDENT ABSENCE PORTAL.
   PLEASE NOTE: It is the student's responsibility to check the date, time and location of the Special Examination.

III. LATE ASSIGNMENTS

IV. Medical Accommodation

1. Requests for Academic Consideration Request Form through STUDENT ABSENCE PORTAL.
2. Requests for academic consideration must include the following components:
   a. Self-attestation signed by the student (*This is only accepted for the first/one absence*)
   b. Medical note. Forged notes and certificates will be dealt with severely. To submit a forged document is a scholastic offence.
   c. Indication of the course(s) and assessment(s) affected by the request
   d. Supporting documentation as relevant
3. Requests without supporting documentation are limited to one per term per course.
4. **Students must request academic consideration as soon as possible and no later than 48 hours after the missed assessment.**
5. Once the request and supporting documents have been received and reviewed, appropriate academic consideration, if granted, shall be determined by the instructor in consultation with the academic advisor, in a manner consistent with the course outline.

   Academic consideration may include extension of deadlines, waiver of attendance requirements for classes/labs/tutorials, or re-weighting of course requirements. Some forms of academic consideration, such as arranging Special Examinations, assigning a grade of Incomplete, or granting late withdrawals without academic penalty, may only be granted by the Academic Advising office of the Faculty of Registration.

V. Religious Accommodation

When scheduling unavoidably conflicts with religious holidays, which (a) require an absence from the University or (b) prohibit or require certain activities (i.e., activities that would make it impossible for the student to satisfy the academic requirements scheduled on the day(s) involved), no student will be penalized for absence because of religious reasons, and alternative means will be sought for satisfying the academic requirements involved. If a suitable arrangement cannot be worked out between the student and instructor involved, they should consult the appropriate Department Chair and, if necessary, the student's Dean.

It is the responsibility of such students to inform themselves concerning the work done in classes from which they are absent and to take appropriate action.

VI. Academic Integrity

In the Faculty of Engineering, we encourage students to create a culture of honesty, trust, fairness, respect, responsibility, and courage, befitting the professional degree you are pursuing.

Please visit Academic Integrity Western Engineering for more information

VII. Academic Offences

Plagiarism means using another's work without giving credit. The university has rules against plagiarism and other scholastic offences. Western Engineering has a zero-tolerance policy on plagiarism. The minimum penalty is zero on the course work and a repeat offence will earn you zero on the course. A third offence may lead to expulsion from the university.
Scholastic Discipline for Undergraduate Students & Cheating, Plagiarism and Unauthorized Collaboration: What Students Need to Know

Students must write their reports, essays and assignments in their own words. Whenever students take an idea or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. University policy states that cheating, including plagiarism, is a scholastic offence. The commission of a scholastic offence is attended by academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning.

All required papers may be subject to submission for textual similarity review to commercial plagiarism detection software under license to the University for the detection of plagiarism. All papers submitted will be included as source documents on the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between the University of Western Ontario and Turnitin.com (http://www.turnitin.com). Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, in the relevant section of the Academic Handbook:
http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf

VIII. Faculty of Engineering AI Policy

The use of generative Artificial intelligence (GenAI) tools won't be discouraged in the Faculty of Engineering. As we pride ourselves on building the future we can't hide from the use of GenAI tools to contribute to the understanding of the course materials. However, the use of GenAI tools in any assignment or contribution during the course will have to be disclosed, as a resource.

GenAI tools use won't be permitted in any type of examination or other assessments where the faculty have prohibited their use. If use of GenAI tools is detected by the instructor in these instances, academic offences penalties might be imposed against the student.

IX. Use of English Policy

In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for improper use of English. Additionally, poorly written work except for the final examination may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

X. Accessibility

Western is committed to achieving barrier free accessibility for persons with disabilities studying, visiting and working at Western. As part of this commitment, there are a variety of services, groups and committees on campus devoted to promoting accessibility and to ensuring that individuals have equitable access to services and facilities. To help provide the best experience to all members of the campus community, please visit the Accessibility Western University for information on accessibility-related resources available at Western.

Students with disabilities may arrange for academic accommodation at Western. For a more detailed explanation, please visit Academic Support & Engagement -Academic Accommodation.

XI. Inclusivity, Diversity, and Respect

The Faculty of Engineering at Western University is committed to creating equitable and inclusive learning environments that value diverse perspectives and experiences. We recognize that university courses often marginalize students based on social identity characteristics such as, but not limited to, Indigeneity, race, ethnicity, nationality, ability, gender identity, gender expression, sexuality, age, language, religion, and socioeconomic status. Understanding this, we strive to facilitate equitable experiences and inclusion within the classroom by respecting and integrating multiple ways of knowing, being, and doing. Please visit the Office of Equity, Diversity and Inclusion.

XII. Health and Well-Being

- Health & Wellness Services – Students - Offers appointment-based medical clinic for all registered part-time and full-time students.
- Mental Health Support - Provides professional and confidential services, free of charge, to students needing assistance to meet their personal, social and academic goals. Services include consultation, referral, groups and workshops, as well as brief, change-oriented psychotherapy.
- Crisis Support - For immediate assistant, please visit Thames Hall Room 2170 or call 519-661-3030. The crisis clinic operates between 11:00 am - 4:30 pm. For after-hours crisis support, click here.
- Gender-Based Violence and Survivor Support - Western is committed to reducing incidents of gender-based and sexual violence and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced gender-based or sexual violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts, here. To connect with a case manager or set up an appointment, please contact support@uwo.ca.

Important Contacts

Engineering Undergraduate Services	SEB 2097	519-661-2130	engugrad@uwo.ca
Electrical and Computer Engineering	TEB 279	519-661-2111 x86264	eceugrad@uwo.ca
Office of the Registrar/Student Central	WSSB 1120	519-661-2100	

Important Links

- WESTERN ACADEMIC CALENDAR
- ACADEMIC RIGHTS AND RESPONSIBILITIES
- ENGINEERING PROGRESSION REQUIREMENTS AND ACADEMIC REGULATIONS
- UNIVERSITY STUDENTS' COUNCIL (USC) - SERVICES
- IMPORTANT DATES AND DEADLINES
- ACADEMIC CONSIDERATION FOR MEDICAL ILLNESS - UNDERGRADUATE STUDENTS
- ACCOMMODATIONS FOR RELIGIOUS HOLIDAYS
- SCHEDULING OF ASSIGNMENTS, TESTS, AND EXAMINATIONS
- STUDENT FORMS
- OFFICE OF THE REGISTRAR
- RETENTION OF ELECTRONIC VERSION OF COURSE OUTLINES (SYLLABI)
- ACADEMIC APPEALS
- STUDENT ABSENCE PORTAL