

University of Waterloo
Department of Electrical & Computer Engineering
ECE 663: Energy Processing
Spring 2024

Instructor: Mehrdad Kazerani (EIT 4171)
mkazerani@uwaterloo.ca

COURSE OUTLINE

Introduction to Power Electronics

Evolution, Scope and Applications

Overview of Power Semiconductor Devices

Diodes, Thyristors, Controllable Switches, Wide-Bandgap Devices, Power Losses in Switches

Power Converter Topologies

Line-Frequency Diode-Rectifiers, Line-Frequency Phase-Controlled Converters, Switch-Mode DC/DC Converters, Switch-Mode DC/AC Converters, Interleaved Converters, Multilevel Converters, AC/AC converters

Modeling and Control Techniques in Power Converters

Hysteresis Control, Pulse Width Modulation (PWM) and Linear Power Amplifier Concept, Phase-Shift Modulation, Space Vector Modulation, Square-Wave Control, Selective Harmonic Elimination, Soft Switching, Average Modeling of Converters, Controller Design

Power Quality:

Harmonic Distortion, Power Quality Indices, Input and Output Low-Pass Filters

Applications of power electronic converters

A subset of: Switch-Mode DC Power Supplies, Power Factor Correction, Motor drives, HVDC Transmission Systems, Flexible AC Transmission Systems (FACTS), Grid Interface of Renewable Energy Sources, Active Power Filter, Grid Interface of Energy Storage Systems, Microgrids

Project: The project description will be given early in the term. The project will be done and reported individually. The deliverable is a report in the IEEE Transactions paper format, composed of the following components: literature review, analysis, modeling, simulation results and suggestions for improvements to the existing solutions.

References:

- Mohan, Undeland, and Robbins, *Power Electronics: Converters, Applications, and Design*, 2nd or 3rd Edition, John Wiley & Sons, Inc., 1995 or 2003.
- D.W. Hart, *Power Electronics*, McGraw Hill, 2011.
- Mehrdad Kazerani, *ECE 663/ECE 463 Lecture Slides*.
- Related Journal Papers

LEARN:

LEARN will be used for posting the course materials, drill problems and solutions, old exams, project description and supporting documents, and announcements. It will also be used for uploading the deliverables by the students to the appropriate drop boxes.

Email Correspondences:

It is preferred that email correspondence is done through LEARN. If personal email is used to contact the instructor, the subject line must start with the course number (ECE 663).

GRADING SCHEME

Project	35%
Midterm Exam	15%
Final Exam	50%
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Total	100%

Notes:

- Those who audit the course are responsible for attendance and the project only.
- To pass the course, a passing mark must be obtained in each component of the course (i.e., project, midterm and final exams combined).
- Missing midterm exam without a valid excuse, or a prearrangement, will result in a mark of ZERO. Missing midterm exam with a valid excuse, or a prearrangement, will result in shifting the midterm exam weight to final exam (midterm: 0%, final exam: 65%).
- The deadline for the project report submission is the last day of lectures.

CONTINENCY PLAN & ALTERNATIVE ARRANGEMENTS FOR CANCELLATIONS AND COVID IMPLICATIONS

- In the case of a short-term (e.g., one-week) cancellation of in-person lectures, whether for the course or University-wide, lectures will be rescheduled during the following weeks.
- In the case of a long-term cancellation of in-person lectures, whether for the course or University-wide, lectures will be held online, and recorded lectures will be made available to students.
- In the case of cancellation of in-person exam (midterm or final), an online version of the exam will be given to students via email, with the same starting time and duration as the cancelled in-person exam. Detailed instructions, outlining how to complete the examination, will be sent to students, before the online exam date.
- For students who cannot attend classes due to self-isolation, and need clarifications or support beyond posted course material, an online meeting will be held.

ACADEMIC INTEGRITY, GRIEVANCE, DISCIPLINE, APPEALS AND NOTE FOR STUDENTS WITH DISABILITIES:

See www.uwaterloo.ca/accountability/documents/courseoutlinestmts.pdf

The information extracted from this website is given below.

Academic Integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [Check www.uwaterloo.ca/academicintegrity/ for more information.]

Grievance: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4,

www.adm.uwaterloo.ca/infosec/Policies/policy70.htm. When in doubt please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline: A student is expected to know what constitutes academic integrity [check www.uwaterloo.ca/academicintegrity/] to avoid committing an academic offence and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate Associate Dean. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline,

www.adm.uwaterloo.ca/infosec/Policies/policy71.htm. For typical penalties check Guidelines for the Assessment of Penalties, www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm.

Appeals: A decision made, or penalty imposed under Policy 70 (Student Petitions and Grievances) (other than a petition) or Policy 71 (Student Discipline) may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72 (Student Appeals) www.adm.uwaterloo.ca/infosec/Policies/policy72.htm.

Note for Students with Disabilities: The Office for persons with Disabilities (OPD), located in Needles Hall, Room 1132, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the OPD at the beginning of each academic term.

(<https://uwaterloo.ca/disability-services/>)