ECE 765

Power System Protection and Relaying

Class Schedule

Course	Meet Days	Meet Time	Location	Instructor(s)
ECE 765 001 [LEC]	**Mon, Wed** *May 5 - Jul 30*	02:30PM - 03:50PM	EIT 3141	Sahar Pirooz Azad *sahar.azad@uwaterloo.ca*
	Fridays *Jul 4, Jul 25*	02:30PM - 03:50PM	EIT 3141	

schedule data automatically refreshed daily

Instructional Team

Instructor: Sahar Azad, Ph.D., PEng

Office: EIT 4017

Email: sahar.azad@uwaterloo.ca

Office Hours: Book an appointment by email

Note: When sending an email to the course instructor:

1. Ensure that the email's subject contains ECE 765.
2. The email is sent from a University of Waterloo mail server with your official UWid. Email from Gmail and the like will not be received.

Piazza

If you have any questions, you can anonymously ask your questions on Piazza. If you don't have access to the course Piazza, you can sign up using the following link:

https://piazza.com/uwaterloo.ca/spring2025/ece765 (1)

This platform will allow you daily to ask your questions anonymously. You can answer each other's questions and I will also monitor the platform on a daily basis. A **2% bonus mark** will be given to the student who achieves the highest participation rate in Piazza in terms of responding to other students' questions.

Course Description

Calendar Description for ECE 765

This course focuses on the protection of various components of a power system including transmission lines, rotating machinery, transformers, busbars, reactors, capacitors and distribution lines. The course will review the fundamental

features of a reliable protection system and will discuss the major components of a protection system including current and voltage transformers, circuit breakers, and relays. Various protection strategies such as nonpilot overcurrent protection, nonpilot distance protection, pilot protection and differential protection will be discussed in this course.

View requirements for ECE 765 (2)

Learning Outcomes

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

Provide an in-depth understanding of power system protection requirements;
Describe the operational principle of the main components of a protection system;
Describe the fundamental principle of various protection methods for the main power system components including transmission and distribution networks, rotating machinery including generators and motors, transformers, and busbars;
Explain the advantages and disadvantages of various protection methods for each power system component and specify the proper protection method for the component in any given power system.

Tentative Class Plan

- **Module 1-Protection system requirements (1 lecture):** Overview of power system structure, causes and types of faults, and protection system main requirements
- **Module 2-Elements of protection systems (2 lectures):** Relay types and operating principles, circuit breaker types and operating principles (optional), and instrument transformers types and operating principles
- **Module 3-Review of symmetrical components and power system fault calculations (2 lectures):** Balanced 3-phase faults, Unbalanced faults, Symmetrical components, and Sequence network construction
- **Module 4-Overcurrent protection (1 lecture):** Principles of overcurrent protection, fuses, sectionalizers and reclosers, time-delay overcurrent relays, and instantaneous overcurrent relays
- **Module 5-Coordination principle of overcurrent protection devices (2 lectures):** Guidelines for coordination of overcurrent protection devices
- **Module 6-Directional overcurrent relays (2 lectures):** Application of directional relays, different connections and maximum torque angles
- **Module 7-Distance protection (2 lectures):** Distance relay characteristics, and factors affecting distance relay performance
- **Module 8-Pilot protection of transmission lines (4 lectures):** Communication channels, directional comparison blocking, directional comparison unblocking, direct underreaching transfer trip, permissive overreaching transfer trip, permissive underreaching transfer trip, and current-based pilot schemes
- **Module 9-Transformer protection (2 lectures):** Overcurrent protection, differential protection, and nonelectrical protection
- **Module 10-Busbar Protection (2 lectures):** Common busbar arrangements and busbar protection
- **Module 11-Generator protection (2 lectures):** Typical power plant layouts, grounding methods for generators and protection principle against stator faults, rotor faults, unbalanced currents, overexcitation, overspeed, abnormal voltages

and frequencies, and loss of excitation

- **Module 12-Motor protection (2 lectures):** Motor failures, thermal protection, stall or locked rotor protection, short circuit protection, ground fault protection, load-loss/load jam protection, overspeed protection, unbalanced current protection, undervoltage protection, and overvoltage protection

Note: The number of lectures for each module may vary based on class progress.

Required Materials & Technologies

Note: Any prices provided in course outlines are best estimates based on recent online prices and do not include shipping or taxes. Prices may vary between retailers.

This course has **no additional costs** for students.

Readings

Title / Name	Notes / Comments	Required	Used Versions Allowed	Price (CAD)
Stanely H. Horowitz, & Arun G. Phadke, Power System Relaying, 4th edition, Wiley (Text-1)	Recommended	Recommended	No	
J. L. Blackburn, Protective Relaying: Principles and Applications, Taylor & Francis Ltd. (Text-2)	Recommended	Recommended	No	
J. Duncan Glover, Mulukutla S. Sarma & Thomas, J. Overbye, Power System Analysis and Design, 5th edition, CENGAGE Learning (Text-3)	Recommended	Recommended	No	

Assessments & Activities

Component / Activity	Date or Due Date	Location / Submission Method	Weight (%)
Assignment I			13%
Asssignment II			13%
Assignmnet III			13%
Assignment IV			13%
Final Exam			50%

The instructor reserves the right to use alternative grading schemes in special circumstances. For example, if an accommodation is necessary, an alternative grading scheme may be used to the benefit of the individual student.

- **Four assignments** are to be given. The assignments will be posted on LEARN after the corresponding modules are covered in class.
- **These assignments are a combination of analytical questions and simulation problems.**
- **Each assignment is worth 13 marks and there are 102 marks in total in this course. Therefore, the assignments will provide 2 additional (bonus) marks.**

- All assignments should be neat and clear. Messy and crumpled solutions will not be marked.
- Solutions to the assignments will be posted on LEARN after the due date of the assignments.
- Students should upload their solutions on LEARN. A separate Dropbox will be created for each assignment on LEARN.
- The final exam will be closed-book; however, you are allowed to bring a summary sheet with you. The summary sheet must be one page, printed on both sides, and formatted on A4 paper..
- The instructor reserves the right to curve any of the assignment grades and the final marks.

Late / Missed Content

- A student missing the final exam will automatically receive a score of zero for that exam.
- Late assignments will not be accepted unless a legitimate reason (illness, religious conviction, etc.) is discussed with the instructor before the due date.

Assignment Screening

Text matching software (Turnitin) will be used to screen assignments in this course. This is being done to verify that the use of all material and sources in assignments is documented. In the first week of the term, details will be provided about the arrangements for the use of Turnitin and alternatives in this course. See Administrative Policy below for more information and links.

Generative AI

This course includes the independent development and practice of specific skills, such as **problem solving**. Therefore, the use of Generative artificial intelligence (GenAI) trained using large language models (LLM) or other methods to produce text, images, music, or code, like Chat GPT, DALL-E, or GitHub CoPilot, **is not permitted** in this class. Unauthorized use in this course, such as running course materials through GenAI or using GenAI to complete a course assessment is considered a violation of Policy 71 [3] (plagiarism or unauthorized aids or assistance). Work produced with the assistance of AI tools does not represent the author's original work and is therefore in violation of the fundamental values of academic integrity including honesty, trust, respect, fairness, responsibility and courage (ICAI [4], n.d.).

You should be prepared to show your work. To demonstrate your learning, you should keep your rough notes, including sources, research notes, brainstorming, drafting notes and prompts. You may be asked to submit these notes along with earlier drafts of your work, either through saved drafts or saved versions of a document. If the use of GenAI is suspected where not permitted, you may be asked to meet with your instructor or TA to provide explanations to support the submitted material as being your original work. If you cannot sufficiently support your work, academic misconduct allegations may be brought to the Associate Dean.

In addition, you should be aware that the legal/copyright status of generative AI inputs and outputs is unclear. More information is available from the Copyright Advisory Committee. [5]

Students are encouraged to reach out to campus supports if they need help with their coursework including:

- Student Success Office [6] for help with skills like notetaking and time management
- Writing and Communication Centre [7] for assignments with writing or presentations
- AccessAbility Services [8] for documented accommodations

- Library [9] for research-based assignments

Administrative Policy

Faculty of Engineering Guiding Practices.

Territorial Acknowledgement: The University of Waterloo acknowledges that much of our work takes place on the traditional territory of the Neutral, Anishinaabeg and Haudenosaunee peoples. Our main campus is situated on the Haldimand Tract, the land granted to the Six Nations that includes six miles on each side of the Grand River. Our active work toward reconciliation takes place across our campuses through research, learning, teaching, and community building, and is centralized within the Office of Indigenous Relations [10].

Inclusive Teaching-Learning Spaces: The University of Waterloo values the diverse and intersectional identities of its students, faculty, and staff. The University regards equity and diversity as an integral part of academic excellence and is committed to accessibility for all. We consider our classrooms, online learning, and community spaces to be places where we all will be treated with respect, dignity, and consideration. We welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability – and other visible and nonvisible differences. We are all expected to contribute to a respectful, welcoming, and inclusive teaching- learning environment. Any member of the campus community who has experienced discrimination at the University is encouraged to seek guidance from the Office of Equity, Diversity, Inclusion & Anti-racism (EDI-R) [11] via email at equity@uwaterloo.ca. Sexual Violence Prevention & Response Office (SVPRO) [12], supports students at UWaterloo who have experienced, or have been impacted by, sexual violence and gender-based violence. This includes those who experienced harm, those who are supporting others who experienced harm. SVPRO can be contacted at svpro@uwaterloo.ca

Religious & Spiritual Observances: The University of Waterloo has a duty to accommodate religious and spiritual observances under the Ontario Human Rights Code. Please inform the instructor at the beginning of term if special accommodation needs to be made for religious observances that are not otherwise accounted for in the scheduling of classes and assignments. Consult with your instructor(s) within two weeks of the announcement of the due date for which accommodation is being sought.

Respectful Communication and Pronouns: Communications with Instructor(s) and teaching assistants (TAs) should be through recommended channels for the course (e.g., email, LEARN, Piazza, Teams, etc.) Please use your UWaterloo email address. Include an academic signature with your full name, program, student ID. We encourage you to include your pronouns to facilitate respectful communication (e.g., he/him; she/her; they/them). You can update your chosen/preferred name at WatIAM. [13] You can update your pronouns in Quest [14].

Mental Health and Wellbeing Resources: If you are facing challenges impacting one or more courses, contact your academic advisor, Associate Chair Undergraduate, or the Director of your academic program. Mental health is a serious issue for everyone and can affect your ability to do your best work. We encourage you to seek out mental health and wellbeing support when needed. The Faculty of Engineering Wellness [15] Program [16] has programming and resources for undergraduate students. For counselling (individual or group) reach out to Campus Wellness and Counselling Services. [17] Counselling Services is an inclusive, non-judgmental, and confidential space for anyone to seek support. They offer confidential counselling for a variety of areas including anxiety, stress management, depression, grief, substance use, sexuality, relationship issues, and much more.

Intellectual Property: Be aware that this course contains the intellectual property of their instructor, TA, and/or the University of Waterloo. Intellectual property includes items such as:

- Lecture content, spoken and written (and any audio/video recording thereof).

- Lecture handouts, presentations, and other materials prepared for the course (e.g., PowerPoint slides).
- Questions or solution sets from various types of assessments (e.g., assignments, quizzes, tests, final exams); and
- Work protected by copyright (e.g., any work authored by the instructor or TA or used by the instructor or TA with permission of the copyright owner).

Course materials and the intellectual property contained therein are used to enhance a student's educational experience. However, sharing this intellectual property without the intellectual property owner's permission is a violation of intellectual property rights. For this reason, it is necessary to ask the

instructor, TA and/or the University of Waterloo for permission before uploading and sharing the intellectual property of others online (e.g., to an online repository).

Permission from an instructor, TA or the University is also necessary before sharing the intellectual property of others from completed courses with students taking the same/similar courses in subsequent terms/years. In many cases, instructors might be happy to allow distribution of certain materials. However, doing so without expressed permission is considered a violation of intellectual property rights and academic integrity.

Please alert the instructor if you become aware of intellectual property belonging to others (past or present) circulating, either through the student body or online.

Continuity Plan - Fair Contingencies for Unforeseen Circumstances (e.g., resurgence of COVID-19): In the event of emergencies or highly unusual circumstances, the instructor will collaborate with the Department/Faculty to find reasonable and fair solutions that respect rights and workloads of students, staff, and faculty. This may include modifying content delivery, course topics and/or assessments and/or weight and/or deadlines with due and fair notice to students. Substantial changes after the first week of classes require the approval of the Associate Dean, Undergraduate Studies.

Declaring absences: [*undergraduate students and/or courses only*] Regardless of the process used to declare an absence, students are responsible for reaching out to their instructors as soon as possible. The course instructor will determine how missed course components are accommodated. Self-declared absences (for COVID-19 and short-term absences up to 2 days) must be submitted through Quest [18]. Absences requiring documentation (e.g., Verification of Illness Form, bereavement, etc.) are to be uploaded by completing the form on the VIF System [19]. The UWaterloo Verification of Illness form [20], completed by a health professional, is the only acceptable documentation for an absence due to illness. Do not send documentation to your advisor, course instructor, teaching assistant, or lab coordinator. Submission through the VIF System, once approved, will notify your instructors of your absence.

Rescheduling Co-op Interviews: Follow the co-op process for rescheduling co-op interviews [21] for conflicts to graded assignments (e.g., midterms, tests, and final exams). Attendance at co-operative work-term employment interviews is not considered to be a valid reason to miss a test.

University Policy

Mental Health: At the University of Waterloo, we are dedicated to supporting your mental and emotional well-being. Our Counselling Services offer confidential support, including individual counselling, workshops, and crisis intervention.
If you're struggling, please reach out for help at 519-888-4096 or visit their website [22] for more information.

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 the Office of Academic Integrity [23] for more information.]

Grievance: A student who believes that a decision affecting some aspect of their university life has been unfair or

unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4 [24]. 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 to avoid committing an academic offence, and to take responsibility for their actions. [Check the Office of Academic Integrity [25] for more information.] 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 [26]. For typical penalties, check Guidelines for the Assessment of Penalties [27].

Appeals: A decision made or penalty imposed under Policy 70, Student Petitions and Grievances [28] (other than a petition) or Policy 71, Student Discipline [29] may be appealed if there is a ground. A student who believes they have a ground for an appeal should refer to Policy 72, Student Appeals [30].

Note for students with disabilities and disabling conditions: The University of Waterloo recognizes is obligations under the Ontario Human Rights Code to accommodate students with known or suspected disabilities and disabling conditions (e.g. medical conditions, injuries, impacts of trauma such as from violence or discrimination) to the point of undue hardship. To support this obligation, AccessAbility Services [31] (AAS) collaborates with all academic departments and schools to facilitate academic accommodations for students with disabilities and disabling conditions without compromising the academic integrity of the curriculum. If you believe you may require academic accommodations (e.g., testing accommodations, classroom accommodations), register with AAS as early in the term as possible by completing the online application [32]. Students already registered with AAS must activate their accommodations for each of their courses at the beginning of each term using AAS' online system. If you require assistance, contact AAS by phone (519-888-4567 ext. 35082), email (access@uwaterloo.ca) or in-person (Needles Hall North, 1st Floor, Room 1401).

Turnitin.com: Text matching software (Turnitin®) may be used to screen assignments in this course. Turnitin® is used to verify that all materials and sources in assignments are documented. Students' submissions are stored on a U.S. server, therefore students must be given an alternative (e.g., scaffolded assignment or annotated bibliography), if they are concerned about their privacy and/or security. Students will be given due notice, in the first week of the term and/or at the time assignment details are provided, about arrangements and alternatives for the use of Turnitin in this course.

It is the responsibility of the student to notify the instructor if they, in the first week of term or at the time assignment details are provided, wish to submit alternate assignment.

Reference: Links from Document

1. https://piazza.com/uwaterloo.ca/spring2025/ece765
2. https://acal.fast.uwaterloo.ca/course/1255/ECE/765
3. https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-71
4. https://academicintegrity.org/images/pdfs/20019_ICAI-Fundamental-Values_R12.pdf
5. https://outline.uwaterloo.ca/author/edit/%E2%80%AFhttps://uwaterloo.ca/copyright-at-waterloo/teaching/generative-artificial-intelligence%C2%A0
6. https://uwaterloo.ca/student-success/resources
7. https://uwaterloo.ca/writing-and-communication-centre/services-0/services-undergraduate-students
8. https://uwaterloo.ca/accessability-services/students
9. https://uwaterloo.ca/library/research-supports/quick-start-guide
10. https://uwaterloo.ca/indigenous

11. https://uwaterloo.ca/equity-diversity-inclusion-anti-racism/
12. https://uwaterloo.ca/sexual-violence-prevention-response-office
13. https://idm.uwaterloo.ca/watiam/
14. https://uwaterloo.ca/quest/help/students/how-do-i/view-or-update-my-personal-information
15. https://uwaterloo.ca/engineering-wellness-program/
16. https://uwaterloo.ca/engineering-wellness-program/
17. https://uwaterloo.ca/campus-wellness/counselling-services
18. https://uwaterloo.ca/quest/help/students/how-do-i/self-declare-absence-undergraduate-students
19. https://vif.uwaterloo.ca/
20. https://uwaterloo.ca/campus-wellness/health-services/student-medical-clinic/verification-illness-services
21. https://uwaterloo.ca/co-operative-education/find-your-co-op-job/find-job-waterlooworks/interview/interview-conflicts
22. https://uwaterloo.ca/students/health-and-well-being/counselling-appointments
23. https://uwaterloo.ca/academic-integrity/
24. https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-70
25. https://uwaterloo.ca/academic-integrity/
26. https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-71
27. https://uwaterloo.ca/secretariat/guidelines/guidelines-assessment-penalties
28. https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-70
29. https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-71
30. https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-72
31. https://uwaterloo.ca/accessability-services/
32. https://uwaterloo.ca/accessability-services/students/applying-academic-accommodations/documentation-information-forms