

Western University
Faculty of Engineering
Department of Electrical & Computer Engineering

**ECE 9402B (Ph.D., M.E.Sc.), ECE 9042B (M. Eng.)
Power System Protection**

COURSE OUTLINE 2022-2023

Description:

This course aims to provide the students with theoretical and practical knowledge on power system protection. The students will become familiar with the components, basic operating principles, main applications, and limitations of protective relays and protection schemes. The students will also learn strategies to design reliable protection systems. As prerequisites of this course, the students are expected to be familiar with power system analysis.

Enrollment Restrictions:

Enrollment in this course is restricted to graduate students in Power Systems, as well as any student that has obtained special permission to enroll in this course from the course instructor as well as the Graduate Chair (or equivalent) from the student's home program.

Instructor Contact Information:

Course instructor: Dr. Firouz Badrkhani Ajaei
Email address: fajaei@uwo.ca
Office: TEB249
Office hours: By appointment

Course Format:

Hybrid

Antirequisites:

ECE4456B – Students who have taken the ECE4456B course at Western are not allowed to take this graduate course.

Prerequisites:

ECE 4464A or equivalent

Required Textbook:

Power System Relaying, 4th Edition
Authors: S.H. Horowitz, A.G. Phadke
Publisher: Wiley, 2014
ISBN 9781118662007

Recommended References:

Protection of Electricity Distribution Networks, 3rd Edition

Authors: J.M. Gers, and E.J. Holmes

Publisher: IET, 2011. Available for download at Western Libraries.

Practical Power System Protection

Authors: L.G. Hewitson, M. Brown, R. Balakrishnan

Publisher: Elsevier, 2004.

Protective Relaying: Principles and Applications

Author: J.L. Blackburn

Publisher: Taylor & Francis Ltd, 2007. Available for download at Western Libraries.

Protective Relaying Theory and Applications

Author: W.A. Elmore

Publisher: Marcel Dekker, 2004. Available at Taylor Library: TK2861.E45 2004.

Topics:

| Topic | Learning Activities | Tentative timeline |
|--|---|--------------------|
| 1. Philosophy of power system protection | <ul style="list-style-type: none">Recorded lecturesOnline review and discussion | Week 1 |
| 2. Relay technologies | <ul style="list-style-type: none">Recorded lecturesOnline review and discussionOnline lab experiments | Weeks 2 and 3 |
| 3. Protection of distribution circuits | <ul style="list-style-type: none">Recorded lecturesOnline review and discussionSample problemsOnline lab experiments | Weeks 4 and 5 |
| 4. Protection of looped circuits using directional over current relays | <ul style="list-style-type: none">Recorded lecturesOnline review and discussionSample problemsOnline lab experiments | Weeks 6 and 7 |
| 5. Protection of transmission lines | <ul style="list-style-type: none">Recorded lecturesOnline review and discussionSample problemsOnline lab experiments | Weeks 8 and 9 |
| 6. Protection of transformers and busbars | <ul style="list-style-type: none">Recorded lecturesOnline review and discussion | Week 10 |
| 7. Protection of generators and motors | <ul style="list-style-type: none">Recorded lectures | Week 11 |

Specific learning outcomes:

| Degree Level Expectation | Weight | Assessment Tools | Outcomes |
|----------------------------------|--------|--|--|
| Depth and breadth of knowledge | 50% | <ul style="list-style-type: none">ExaminationsQuizzes | <ul style="list-style-type: none">Understanding of advanced concepts and theoriesAwareness of important current problems in the field of studyUnderstanding of computational and/or empirical methodologies to solve related problems |
| Application of knowledge | 40% | <ul style="list-style-type: none">LabExaminations | <ul style="list-style-type: none">Ability to apply knowledge in a rational way to analyze a particular problemAbility to use coherent approach to design a particular engineering system using existing design tools |
| Awareness of limits of knowledge | 10% | <ul style="list-style-type: none">LabExaminations | <ul style="list-style-type: none">Awareness of the need of assumptions in complex scientific analyses and their consequencesUnderstanding of the difference between theoretical and empirical approachesAbility to acknowledge analytical limitation due to complexity of practical problems |

Assessments:

| Component | Material Covered | Weight (%) |
|-------------------|------------------|------------|
| Quizzes | Topics 1-7 | 10 % |
| Laboratory | Topics 1-6 | 20 % |
| Midterm Test | Topics 1-3 | 30 % |
| Final Examination | Topics 1-7 | 40 % |

Intellectual Property Statement: Course material (i.e. course content, videos, solutions, practice questions and other supplementary material posted on OWL) is the intellectual property of your instructors and course developers and is made available to you for your personal use in this course. *Sharing, posting, selling or using this material outside your personal use in this course is considered to be an infringement of intellectual property rights.*

Activities in which collaboration is permitted:

- Laboratory experiments
- Class discussions
- Quizzes, if group work is permitted by the instructor

Activities in which students must work alone (collaboration is not permitted):

- Final examination and midterm test

Cheating, Plagiarism/Academic Offenses:

Academic integrity is an essential component of learning activities. Students must have a clear understanding of the course activities in which they are expected to work alone (and what working alone implies) and the activities in which they can collaborate or seek help; see information above and ask instructor for clarification if needed. Any unauthorized forms of help-seeking or collaboration will be considered an academic offense. University policy states that cheating is an academic offence. If you are caught cheating, there will be no second warning. Students must write their essays and assignments in their own words. Whenever students take an idea or a passage of text from another author, they must acknowledge their debt both by using quotation marks where

appropriate and by proper referencing such as footnotes or citations. Plagiarism is a major academic offence. Academic offences are taken seriously and attended by academic penalties which may include expulsion from the program. Students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence at the following website: https://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_grad.pdf

Course delivery: The course will be delivered using a flipped classroom teaching style, meaning that you will watch recorded lecture videos before attending the in-person meetings. The in-person meetings will be held during the scheduled class time (Wednesdays from 4:30 pm to 6:30 pm EASTERN time zone) for reviewing the lectures, solving problems, taking quizzes, and having discussions.

The one-hour scheduled class time (Tuesdays from 9:30 am to 10:30 am EASTERN time zone) will be used as consultation hour (by appointment).

Labs will be in-person.

Quizzes: A quiz will be given during each lecture, except the first lecture. Student responses may be collected online (using iClicker or another tool) or on paper. Students may be requested to work in groups or individually.

Laboratory: There will be 4 lab experiments. Each experiment will be conducted after the corresponding topic is covered in the lectures. The lab schedule will be announced on the OWL course website.

Midterm Test: The exam date will be announced on the OWL course website. The exam will be in mixed format (multiple choice questions and problems).

Final Examination: The final examination will be in mixed format and will cover all course content.

Late Submission Policy: All lab reports are due by 23:55 on the due date. Late submissions will not be accepted. In case the report cannot be submitted through OWL (due to technical issues), the students can submit them by sending an email to the instructor.

Use of English: 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 with the exception of 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.

Attendance: Any student who, in the opinion of the instructor, is absent too frequently from class, laboratory, or tutorial periods will be reported to the Dean (after due warning has been given). On the recommendation of the department, and with the permission of the Dean, the student will be debarred from taking the regular final examination in the course.

Conduct: Students are expected to follow proper etiquette to maintain an appropriate and respectful academic environment. Any student who, in the opinion of the instructor, is not appropriately participating in course activities and/or is not following the rules and responsibilities associated with

the course activities, will be reported to the Associate Dean (Graduate) (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Associate Dean (Graduate), the student could be debarred from completing the assessment activities in the course as appropriate.

Health/Wellness: As part of a successful graduate student experience at Western, we encourage students to make their health and wellness a priority. Western provides several health and wellness related services to help you achieve optimum health and engage in healthy living while pursuing your graduate degree. Information regarding health- and wellness-related services available to students may be found at <http://www.health.uwo.ca/>.

Students seeking help regarding mental health concerns are advised to speak to someone they feel comfortable confiding in, such as their faculty supervisor, their program director (graduate chair), or other relevant administrators in their unit. Faculty of Engineering has a Student Wellness Counsellor. To schedule an appointment with the counsellor, contact Kristen Edwards (khunt29@uwo.ca) via confidential email and you will be contacted by our intake office within 48 hours to schedule an appointment.

Students who are in emotional/mental distress should refer to Mental Health@Western: <http://www.uwo.ca/uwocom/mentalhealth/> for a complete list of options about how to obtain help.

Sickness: Students should immediately consult with the Instructor (for a particular course) or Associate Chair (Graduate) (for a range of courses) if they have problems that could affect their performance. The student should seek advice from the Instructor or Associate Chair (Graduate) regarding how best to deal with the problem. Failure to notify the Instructor or the Associate Chair (Graduate) immediately (or as soon as possible thereafter) will have a negative effect on any appeal. Obtaining appropriate documentation (e.g., a note from the doctor) is valuable when asking for accommodation due to illness.

Students who are not able to meet certain academic responsibilities due to medical, compassionate or other legitimate reason(s), could request for academic consideration. The Graduate Academic Accommodation Policy and Procedure details are available at: <https://www.eng.uwo.ca/graduate/current-students/academic-support-and-accommodations/index.html>

Accessible Education Western (AEW): Western is committed to achieving barrier-free accessibility for all its members, including graduate students. As part of this commitment, Western provides a variety of services devoted to promoting, advocating, and accommodating persons with disabilities in their respective graduate program.

Graduate students with disabilities (for example, chronic illnesses, mental health conditions, mobility impairments) are strongly encouraged to register with Accessible Education Western (AEW): http://academicsupport.uwo.ca/accessible_education/index.html

AEW is a confidential service designed to support graduate and undergraduate students through their academic program. With the appropriate documentation, the student will work with both AEW and their graduate programs (normally their Graduate Chair and/or Course instructor) to ensure that appropriate academic accommodations to program requirements are arranged. These

accommodations include individual counselling, alternative formatted literature, accessible campus transportation, learning strategy instruction, writing exams and assistive technology instruction.