

**Western University**  
**Faculty of Engineering**  
**Department of Electrical and Computer Engineering**

**ECE 4456B: Power System Protection**

**Course Outline 2020-21**

**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.

**Instructor:** Dr. Firouz Badrkhani Ajaei  
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Consultation hours: By appointment

**Academic Calendar Copy:**

To allow students to: a) gain an understanding of the basic principles of protective relays and b) have a practical understanding of protection schemes for electrical power systems and equipment.

**Contact Hours:** 3 lecture hours, 1 laboratory hours, 0.5 course.

**Prerequisites:** ECE4464A

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. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

**CEAB Academic Units:** Engineering Science 75%, Engineering Design 25%.

### Required Textbook:

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

### Recommended References:

*Protection of Electricity Distribution Networks*, 3<sup>rd</sup> 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.

### General Learning Objectives (CEAB Graduate Attributes)

Knowledge Base	I	Use of Engineering Tools	I	Impact on Society and the Environment	
Problem Analysis	I	Individual and Team Work		Ethics and Equity	
Investigation		Communication Skills		Economics and Project Management	
Design	I	Professionalism		Life-Long Learning	

### Topics and Specific Learning Objectives:

#### 1. Philosophy of power system protection

At the end of this section, a successful student will be able to describe:

- a. necessity of protecting power systems and power equipment
- b. various aspects of power system protection

#### 2. Relay technologies

At the end of this section, a successful student will understand:

- a. main elements of protection systems
- b. protection relay hardware

- c. relay technologies, i.e., electromechanical, solid-state and microprocessor based relays

### 3. Protection of distribution circuits

At the end of this section, a successful student will be able to:

- a. select proper current and voltage transformers for distribution system protection
- b. determine overcurrent relay settings and coordinate overcurrent relays

### 4. Protection of looped circuits using directional over current relays

At the end of this section, a successful student will be able to:

- a. describe the need for directional overcurrent relays
- b. determine directional overcurrent relay setting to enable protection coordination

### 5. Protection of transmission lines

At the end of this section, a successful student will be able to:

- a. describe the need for distance protection and its basic operation principles
- b. determine setting parameters of distance relays
- c. describe basic operation principle of communication aided protection schemes
- d. determine setting parameters of communication aided protection schemes

### 6. Protection of transformers and busbars

At the end of this section, a successful student will be able to:

- a. describe basic operation principle of differential protection systems
- b. demonstrate an understanding of transformer and busbar protection
- c. determine setting parameters for transformer and busbar protection

### 7. Protection of generators and motors

At the end of this section, a successful student will be able to:

- a. demonstrate knowledge of generator and motor protection

**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.*

**Classes:** The lectures will be recorded and posted on the course OWL site.

Classes will be held live on ZOOM during the scheduled class time (Fridays from 8:30 am to 10:30 am EASTERN time zone). These two-hour classes will be used for reviewing and problem solving.

The one-hour scheduled class time (Thursdays from 5:30 pm to 6:30 pm EASTERN time zone) will be used as consultation hour (by appointment) whenever necessary.

**Online Activities:** This course requires the students to engage in online activities such as downloading and watching lecture videos, attending online classes and participating in the class discussions and group activities, taking online tests, and submitting assignments and lab reports through OWL. Each student is expected to have access to a computer equipped with a microphone and a camera.

**All of the remote learning sessions for this course will be recorded.**

The data captured during these recordings may include your image, voice recordings, chat logs and personal identifiers (name displayed on the screen). The recordings will be used for educational purposes related to this course, including evaluations. The recordings may be disclosed to other individuals participating in the course for their private or group study purposes. Please contact the instructor if you have any concerns related to session recordings.

Participants in this course are not permitted to record the sessions, except where recording is an approved accommodation, or the participant has the prior written permission of the instructor.

**Evaluation**

<b>Course Component</b>	<b>Weight</b>
Homework Assignments	20 %
Laboratory	10 %
Midterm Test	35 %
Final Examination	35 %

**Homework Assignments:** Each student must independently work on the assignments and prepare/submit their own results. In other words, the students are not allowed to share solutions.

**Laboratory:** There will be no in-person labs. The instructions and data required to complete the experiments online will be provided through OWL. Each student must submit his/her lab report as a single PDF file through OWL.

**Midterm Test:** The online mid-term exam will be given through the course OWL page. The exam date will be announced on the OWL course website. The exam will be in mixed format (multiple choice questions and problems). The students must independently answer the questions without sharing information with each other.

**Final Examination:** The final examination will be in mixed format and will cover all course content. The students must independently answer the questions without sharing information with each other.

**Assignment and Lab Report Submission:** All assignments and lab reports must be submitted electronically via OWL (hard copy will not be accepted). Each submission must be a single PDF file. Any computer code or model that is developed by the student as part of the solution for the assignment/lab must be submitted along with the PDF file. The files should not be compressed.

**Late Submission Policy:** All assignments and lab reports are due by 23:55 on the due date. Late submissions will not be accepted. In case the assignment/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.

**Absence due to Illness or Other Circumstances:** Students should immediately consult with the instructor or department Chair if they have any problems that could affect their performance in the course. Where appropriate, the problems should be documented (see the attached “Instructions for Students Unable to Write Tests or Examinations or Submit Assignments as Scheduled”). The student should seek advice from the instructor or department Chair regarding how best to deal with the problem. Failure to notify the instructor or department Chair immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

For more information concerning medical accommodations, see the relevant section of the Academic Handbook:

[http://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/accommodation\\_medical.pdf](http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_medical.pdf)

For more information concerning accommodations for religious holidays, see the relevant section of the Academic Handbook:

[http://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/accommodation\\_religious.pdf](http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_religious.pdf)

**Missed Midterm Examination:** If a student misses a midterm examination, she or he must follow the Instructions for Students Unable to Write Tests and provide documentation to Undergraduate Services Office within 24 hours of the missed test. If accommodation is granted, the instructor will decide whether to provide a make-up or allow reweighting, where reweighting means the marks normally allotted for the component will be added to the final exam. If no reasonable justification for missing the test can be found, then the student will receive a mark of zero for the test.

If a student is going to miss the midterm examination for religious reasons, they must inform the instructor in writing within 48 hours of the announcement of the exam date or they will be required to write the exam.

**Cheating and Plagiarism:** Students must write their 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](http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf)

**Use of Electronic Devices:** During lectures, students may use laptops, tablet computers, or smart phones to access the course OWL site. Students are not allowed to use any electronic devices other than non-programmable calculators during exams. Please contact the course instructor if this policy adversely affects the accessibility of the course.

**Policy on Repeating All Components of a Course:** Students who are required to repeat an Engineering course must repeat all components of the course. No special permissions will be granted enabling a student to retain laboratory, assignment, or test marks from previous years. Previously completed assignments and laboratories cannot be resubmitted by the student for grading in subsequent years.

**Internet and Electronic Mail:** Students are responsible for regularly checking their Western e-mail and the course web site (<https://owl.uwo.ca/portal/>) and making themselves aware of any information that is posted about the course. Students must copy the course instructor on all emails they send to the TAs.

**Accessibility:** Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 519-661-2111 ext. 82147 for any specific question regarding an accommodation.

**Support Services:**

Office of the Registrar, <http://www.registrar.uwo.ca/>

Student Development Centre, <http://www.sdc.uwo.ca/>

Engineering Undergraduate Services, <http://www.eng.uwo.ca/undergraduate/>

USC Student Support Services, <http://westernusc.ca/services/>

Students who are in emotional/mental distress should refer to Mental Health @ Western, [http://www.health.uwo.ca/mental\\_health/](http://www.health.uwo.ca/mental_health/), for a complete list of options about how to obtain help.