

Western University  
Faculty of Engineering  
Department of Electrical and Computer Engineering

ECE 9402B (MEng and PhD)

# Power System Protection

Course Outline – Winter 2017

## 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, calculus, matrix algebra, Laplace and Fourier transforms, and Fourier series.

**Instructor:** Dr. Firouz Badrkhani Ajaei  
Room: TEB 249  
Phone: 519-661-2111 ext. 88428  
Email: [fajaei@uwo.ca](mailto:fajaei@uwo.ca)  
Consultation hours: By appointment

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

**Prerequisites:** ECE4464A or equivalent

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.

## Required Textbook:

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

### **Recommended References:**

Protective Relaying: Principles and Applications, Author: J.L. Blackburn  
Taylor & Francis Ltd, 2007. Available for Download at Taylor Library: <http://www.lib.uwo.ca>.  
ISBN: 0824709721

Protective Relaying Theory and Applications, Author: W.A. Elmore  
Marcel Dekker, 2004. Available at Taylor Library: TK2861.E45 2004.  
ISBN: 0824709721

### **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 setting parameters 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 setting parameters and coordinate directional overcurrent relays

#### **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

## Evaluation

Course Component	Weight
Laboratory	10 %
Midterm Test	20 %
Final Examination	40 %
Project	30% (20% for report and 10% for presentation)

To obtain a passing grade in the course, a mark of 50% or more must be achieved on the final examination as well as on the laboratory. A final examination or laboratory mark < 50% will result in a final course grade of 48% or less.

**Laboratory:** Various industrial relay software and hardware will be used in the lab to provide the students with hands-on experience and help them become familiar with engineering tools used for power system protection.

**Midterm Test:** The mid-term exam will be closed book and will be held during course lecture hours. Only non-programmable calculators will be allowed. The date will be announced on the OWL course website.

**Final Examination:** The final examination will cover all course content and will be closed book. The exam will take place during the regular examination period. Only non-programmable calculators will be allowed.

**Project:** Students are required to complete a project that involves simulation and analysis of a power system and investigation of its protection issues/challenges. The project subject will be determined in consultation with the instructor. The project provides the students with an opportunity to experience some of the challenges that they may face in their future work/research activities. The students must submit their proposed subject before the mid-term exam. The instructions for the content of the proposals and the project requirements will be provided on the course website.

The project reports should be prepared according to the IEEE PES conference paper format (templates are available on the IEEE PES website). The quality of the text and illustrations in the report will be also evaluated. The deadline for submission of the project reports is the end of the last class. The project presentations will be made during the last class. All presentation slides must be submitted before the last class.

**Lab Report Submission:** All 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 Examinations:** If a student misses a midterm examination, the exam will not be rescheduled. The student must follow the Instructions for Students Unable to Write Tests and provide documentation to their department within 24 hours of the missed test. The department will decide whether to allow the reweighting of the test, where reweighting means the marks normally allotted for the midterm 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.

**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.