School of Electrical Engineering & Telecommunications
University of New South Wales

ELEC4617 – POWER SYSTEM PROTECTION

Course Outline for S2, 2013

Course Objectives:

Power system protection is an integral part of every power system. All power equipment including power generators, step-up transformers, step-down transformers, transmission lines, power capacitors and electric motors and other loads etc need protection. The necessity for protection is incurred by all kinds of contingencies such as equipment failure due to insulation deterioration, lightning strike, short-circuit by nature force or creature-made happenings, inappropriate operation of power system and other inadvertent incidences. Some power equipment is very expensive such as MW generators which could cost millions of dollars. Furthermore outage due to failure of power system causes severe damage to economy and inconvenience to people's daily life. A properly designed protection can ensure power supply cut to minimum users yet continue supply power to other end users in case that a fault occurs in the system. It is a sophisticated art which needs a systematic study in order to master. All these call for a new module for undergraduate students to learn in the field of power system protection.

The course is aimed at students who have been introduced with fundamental knowledge of power system. The objectives of this course are after taking this course the students will have a deep understanding on the concepts of power system protections, instrument transformers, fundamentals of relaying, overcurrent protection and coordination, directional overcurrent protection, differential protection, distance protection, distributed generation protection, IEC61850 based substation automation etc.

Opportunities:

The course is intended for students who may want to learn more comprehensive knowledge in power engineering. Since power system protection is an integral part of every power system, understanding its design prepares power engineering graduates better for their future career in this sector.

Brief Syllabus:

UOC6 HPW4

The topics to be covered in this course will include: fundamental concepts of protection, protection schemes for various power system configurations. Review on fault current calculations:

study of sequence components, symmetrical and unsymmetrical faults. Protection devices: fuses, circuit breakers, relays; operating principles, device rating determination, relay setting and coordination. Instrument transformers (CTs and VTs): selection, transient performance. Distance protection; Differential protection; Overcurrent protection and its coordination; Directional overcurrent protection.

Course Content	**Hours**
1. Introduction to power system protection	1.5
2.Review on fault analysis	1.5
3. Relaying: operating principles	2.0
4. Current and voltage transformers and circuit breakers and fuses	6.0
5.Overcurrent protection and its coordination	4.5
6.Directional overcurrent protection	4.5
7.Differential overcurrent protection	5.0
8.Distance protection	5.0
9.Islanding detection, distributed and renewable power generation protection and load shedding	1.0
10.IEC61850 based substation automation including protection	1.0
Total	32.0

Staff Contact Details

Position	**Name**	**Email**	**Availability; times and location**	**Phone**
Lecturer	Dr D.M. Zhang	daming.zhang@unsw.edu.au	Room EET 124B	x54070

Aims of this course

The aim of this course is to equip students with fundamental knowledge of power system protection.

Student Learning Outcomes and Graduate attributes

At the conclusion of this course, the students will be able to:

1. understand the basic working mechanism of instrument transformers and their selection for a specific protection scheme design;
2. understand the working mechanism of circuits breakers and their selection for each of protection scheme design;
3. understand the concept of different types of relays, including differential relay, ohm relay, mho relay, directional relay, distance relay, reactance relay etc and their selection for each protection scheme design;
4. understand how to design different protection schemes including overcurrent protection scheme, directional overcurrent protection scheme, differential protection

scheme, distance protection scheme and protection scheme for distributed generation especially renewable energy system etc;

5. understand power system protection coordination.

Lecture Notes

Lecture notes written by the lecturer for each section will be available from the course webpage. These will be based on the following text books and other reference material which will be cited within the lecture notes.

All lecture notes, assignments, tutorial, laboratory test manuals and technical report topics for this course can be downloaded on the MOODLE webpage. Students will be expected to bring the printed lecture notes and tutorial sheets into the lecture/tutorial room.

Tutorials:

Lectures will be supplemented with problem solving tutorial sessions. There will be seven tutorial sessions. The problem-solving sessions will be on most recently covered topics.

Laboratory tests

There are four accompanying laboratory experiments as shown below.

Laboratory 1: Signal processing for digital protective relaying;
Laboratory 2: Implementation of Digital Relaying in Simulink;
Laboratory 3: Transformer differential protection using SEL-787;
Laboratory 4: Overcurrent and Over/Under frequency protection using SEL-751A.

Assessment:

Students will be assessed according to the following scheme:

- **Final examination (65%):** The exam is a standard closed-book 3 hours written examination, covering all aspects of the course that have been presented in the lectures and tutorials. The examination tests analytical and critical thinking and general understanding of the course material. Assessment is a graded mark according to the correct fraction of the answers to the exam questions.
- **Quiz (15%):** There is one quiz, which weighs 20% and is of one and a half hours duration and is in form of closed-book. It is provided in order to get early feedback on students' performance.
- **Laboratory (20%):** There are four laboratory sessions, each of which counts 5%.

Textbooks:

1. Protective Relaying: Principles and Applications, Third Edition, J. Lewis Blackburn, Thomas J. Domin, CRC Press, 2007.
2. Power system relaying, Horowitz, Stanley H. Phadke, Arun G, 3rd edition, Chichester, West Sussex, New York: Wiley 2008.
3. Digital protection for power system, AT Johns and SK Salman, IEE Power series 15, Peter Peregrinus Ltd., 1995.

References:

4. Power System Analysis, John J. Grainger and William D. Stevenson, JR., McGraw-Hill, 1994.
5. Power system relaying, Horowitz, Stanley H. Phadke, Arun G, 3rd edition, Chichester, West Sussex, New York: Wiley 2008.
6. Power system protection, P.M. Anderson, Wiley-Interscience, 1999.
7. Power system protection and communications, Akhtar Kalam, DP Kothari, New Age Science, 2010.
8. INSTRUMENT TRANSFORMERS AND PROTECTION SETTINGS, RASTKO ZIVANOVIC, School of Engineering Systems, The Adelaide University, Adelaide, SA, API sponsored notes.
9. TELECOMMUNICATIONS AND COMMUNICATIONS PROTOCOLS, AKHTAR KALAM, School of Engineering and Science Victoria University Adelaide, SA, API sponsored notes.
10. PROTECTION OF TRANSMISSION AND DISTRIBUTION NETWORKS, ARINDAM GHOSH, School of Engineering Systems Queensland University of Technology Brisbane, Qld, API sponsored notes.
11. Protection of Electricity Distribution Networks, 2nd Edition, Juan M. Gers and Edward J. Holmes, The Institution of Electrical Engineers, 2004.
12. Grid converters for photovoltaic and wind power systems, Remus Teodorescu, Marco Liserre and Pedro Rodriguez, Wiley, 2011.