ELEC4612
Power System Analysis

COURSE OUTLINES - Session 2, 2010

1. Course Staff

Course convener/lecturer: Dr. Toan Phung, room EE107, toan.phung@unsw.edu.au
Laboratory demonstrator: Mr. Maziar Shareghi Boroujeni

2. Course Details

Credits: This is a 6 UoC course; expected workload is 10-12 hours per week throughout the 12 week session.

Contact hours: Lectures start from week 1, labs start from week 2, and tutorials start from week 3. The course consists of 2 hours of lectures per week, 1 hour of tutorials per fortnight, and 3 hours of laboratory sessions per fortnight:

Lectures: Tuesdays, 10-12, room ElecEngG24
Laboratory: Mondays, 09-12, room EE130 (even/odd weeks)
            Mondays, 15-18, room EE130 (even/odd weeks)
Tutorials: Mondays, 13-14, room Webst 302 (even/odd weeks)

Consultations: Students are encouraged to use the open consultation hour (Mondays 14-15, Tuesdays 12-13) rather than contact by email. Students may seek consultation with the course convener at other times by appointment.

3. Course Information

Context: Power systems are complex networks of generators and loads interconnected via transmission lines and various types of equipment and apparatus (transformers, switchgear, etc). An overview of modern power systems meeting present and future challenges involves understanding the fast changing structure of this system, the behavior of its components under steady state, dynamic and transient conditions, in order to be able to evaluate the response of this complex system to variation of loads, and to determine how this system can be controlled to supply the loads reliably while it is economical and safe to the environment.

Aims: The course will provide students with essential knowledge in the mathematical techniques to analyze power systems. The two primary aims are:
- Steady-state analysis of power flow in power system networks.
- Transient analysis of short-circuit faults in power system networks.

Topics covered comprise: review of the basic concepts used in power system analysis: phasors, complex power, three phase systems and per-unit; introduction of equivalent circuit models for power system components including transformers, generators, transmission lines and loads; application of network matrices techniques and power flow analysis to study the steady-state and dynamic behavior of power systems; power system fault calculations including: symmetrical components, symmetrical faults, and unsymmetrical faults; surge propagation during transients in power system; power system stability by introduction of swing equation, and a multi-machine system; power system protection principles; power system control and economic dispatch.

**Relation to other courses:** The course is a fourth year professional elective offered to students following a BE (Elec. Eng.) course at UNSW. The course gives the foundations for power system network analysis and design; as such, the course would normally be taken concurrently with thesis work in the energy systems area.

**Pre-requisites:** The pre-requisite for the course is ELEC3105, Electrical Energy.

**Assumed knowledge:** It is further assumed that the students are familiar with MatLab, and have a good computer literacy.

**Following courses:** Some of the topics covered in this course are expanded in more details in a post-graduate course ELEC9715, Electricity Industry Operation and Control. This is one of the specialisation courses for a Master degree in Engineering Science (Energy Systems).

### 4. Learning outcomes

After the successful completion of the course, the student will be able to:

- Model major types of components used in electrical power systems.
- Analyze different types of short-circuit faults and over-voltage transients.
- Calculate the steady-state power flow in a power system.
- Calculate the power system dynamics and its stability.
- Determine the economic dispatch in a power system.
- Understand the power system control and protection.

The course delivery methods and course content address a number of core UNSW **graduate attributes;** these include:

- Development of in-depth knowledge and understanding in the discipline.
- Development of analytical and critical thinking, which is addressed by the tutorial exercises and class tests.
- Information literacy - the skills to appropriately locate, evaluate and use relevant information.
- The ability to engage in independent and reflective learning.
- Development of effective communication, which is addressed by the laboratory reports.
- Team and collaborative working skills (via laboratory work).

Please refer to [http://www.eng.unsw.edu.au/pc/graduate-attributes](http://www.eng.unsw.edu.au/pc/graduate-attributes) for more information about graduate attributes.
5. Teaching strategies

The course consists of the following elements: lectures, laboratory work, home work, and tutorials:

Lectures:
Students are expected to attend the lectures and prepare themselves for them. The lectures provide the students with a focus on the core material in the course. Generic features and model of various components in a typical power system network are explained. This is further illustrated with practical examples from Australian power utility installations. Mathematical tools and computer-aided analysis are then used to convey a qualitative understanding of critical issues affecting the power system modeling and its analysis. This in turn leads students to an appreciation of the steady state operation, power flow calculation, surge propagation, system stability, power system control and protection. The basic principles covering the power system analysis during steady state, dynamics and transient operation are presented and then illustrated by examining a wide range of examples simulating a small power system.

Laboratory work:
The laboratory work provides the student with experience of power system model computation and analysis through application of different softwares (PowerWorld, ATP-EMTP) and exposure to modeling and analysis of simulated power systems. Students will work in groups of two (or one). There will be five three-hour experiments in total. The experiments will contain material that may not be covered in lectures until after the experiment is done. This requires that the laboratory sheets must be read thoroughly before the laboratory session. Students must come prepared for the laboratory sessions; the laboratory sessions are short, so this is the only possible way to complete the given tasks.

Tutorials:
The tutorial sessions provide personal assistance to students in solving problems. A total of 5 problem sets will be presented throughout the semester and some of these will be worked through during the tutorials. The tutorials take the student through all critical course topics and aim to exercise the students’ analytical and critical thinking skills. Students are strongly encouraged to complete all the tutorial problems as these help to develop in-depth quantitative understanding of the course materials. During tutorials, students will also be invited to raise any concepts or topics covered in lectures with which they are experiencing difficulty and required another explanation. Tutorials are also opportunities for interactive discussion on any questions, issues or topics relevant to the course.

Home work:
The class lectures can only cover the course material to a certain depth; students must down-load the lecture notes (from the course web site) and reflect on its content as preparation for the lectures to fully appreciate the course material. Further research and reading from the recommended list of text/reference books are also required. The ability to read the literature, identify relevant parts and extract critical information with the aid of the lectures is regarded as an essential component of this course. Also, a significant component of home work is preparation for laboratory, tutorials, and writing laboratory reports.
6. Assessment details

There are three components of the assessment in this course:

- Laboratory work: 15% overall weight
- Quizzes: 20% overall weight
- Final examination: 65% overall weight

Assessment task due dates are given in the course schedule. Note that there are no marks awarded for tutorial work.

Laboratory work: Students are required to attend all the scheduled laboratory sessions. Assessment of the laboratory component will be on the basis of (i) a detailed written report (5% weight) to be submitted on a selected experiment, (ii) a practical test (5% weight) to assess students’ competence in using the simulation program to build up and analyse a power system network, and (iii) oral examinations (5% weight) conducted by the demonstrators during each laboratory session. Marks are awarded based on sound explanation of the experiment concept and theoretical analysis, correct computed results and their interpretation. Students should thus use a laboratory notebook to record detailed documentation of the work performed. A satisfactory performance (50% or greater) in the laboratory component is a necessary requirement to pass this course, irrespective of the marks obtained in the other components. Reports are due on the due date by 5pm. Late submissions carry a 50% penalty for the first week and will not be accepted beyond one week delay. Delays on medical grounds are accepted. The reports should be dropped into the school assignment box next to room EEG12A.

Quizzes: There are two quizzes, each weights 10% and is of one hour duration, closed-book, held during the lecture time through the semester. They are provided in order to get early feedback on student performance. The quizzes test the students general understanding of the course material.

Final examination: The exam in this course 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 exam format will be similar to the previous years’ examinations. The examination tests analytical and critical thinking and general understanding of the course material in a controlled fashion. Assessment is a graded mark according the correct fraction of the answers to the exam questions.
7. Tentative Course Schedule

| Wk 1: | Course overview  
| Topic 1: Overview of power systems engineering  (Textbook Ch.1) |

| Wk 2: | Topic 1 (cont.): Review of basic concepts & Introduction to PowerWorld Simulator  
| (Txt Ch.2)  
| Lab 1 |

| Wk 3: | Topic 2 - Power System Components: Transformers (Txt Ch.3) & Synchronous Generator  
| Lab 1 (odd week group); Tutorial set 1. |

| Wk 4: | Topic 2 (cont.) Transmission lines (Txt Ch.4,5) & Power system loads  
| Lab 2; Tutorial set 1; Quiz 1. |

| Wk 5: | Topic 3: Steady State Operation of Power Systems: Load flow studies(Txt Ch.6)  
| Lab 2 (odd week group); Tutorial set 2. |

| Wk 6: | Topic 4: Faults Analysis (Symmetrical Faults) (Txt Ch.7)  
| Lab 3; Tutorial set 2. |

| Wk 7: | Topic 4 (cont.) (Symmetrical Components & Unsymmetrical Faults) (Txt Ch.8&9)  
| Lab 3 (odd week group); Tutorial set 3. |

| Wk 8: | Topic 5: Power system protection (Txt Ch.10)  
| Lab 4; Tutorial set 3. |

| Wk 9: | Topic 6: Power system control and Economic dispatch (Txt Ch.11)  
| Lab 4 (odd week group); Tutorial set 4. |

| Wk 10: | Topic 7: surge propagation on transmission lines or cables, overvoltage protection, insulation coordination & Introduction to ATP Software  
| (Txt Ch.12)  
| Lab 5; Tutorial set 4; Quiz 2. |

| Wk 11: | Topic 8: Transient Stability (Txt Ch.13)  
| Lab 5 (odd week group); Tutorial set 5. |

| Wk 12 | Topic 8 (cont.)  
| Practical test; Tutorial set 5. |

| Wk 13: | Revision  
| Practical test (cont.); Lab report due. |

8. Resources for Students

Textbooks:
- Lecture notes developed by the convener are available on-line for download from the course web site.

Reference books:
The following references will each cover parts of the course only. They are listed in no particular order of importance:
On-line resources:
The web site for this course is: [https://subjects.ee.unsw.edu.au/elec4612/](https://subjects.ee.unsw.edu.au/elec4612/). It contains lecture notes, tutorials, laboratory materials, past exam papers, as well as other relevant information and announcements about this course.

9. Other Matters

**Academic Honesty and Plagiarism**

Plagiarism is the unacknowledged use of other people’s work, including the copying of assignment works and laboratory results from other students. Plagiarism is considered a serious offence by the University and severe penalties may apply. For more information about plagiarism, please refer to [http://www.lc.unsw.edu.au/plagiarism/](http://www.lc.unsw.edu.au/plagiarism/)

All submitted reports and assignments must have an attached cover-sheet that declares that the work detailed in the report/assignment is entirely that of the named student(s) only. The form is available from the EE&T School web site: [http://scoff.ee.unsw.edu.au/forms/forms.htm](http://scoff.ee.unsw.edu.au/forms/forms.htm)

**Continual Course Improvement**

Students are advised that the course is under constant revision in order to improve the learning outcomes of its students. Please forward any feedback (positive or negative) on the course to the course convener or via the Course and Teaching Evaluation and Improvement Process.

**Administrative Matters**

On issues and procedures regarding such matters as special needs, equity and diversity, occupational health and safety, enrolment, rights, and general expectations of students, please refer to the School policies, see [http://scoff.ee.unsw.edu.au/](http://scoff.ee.unsw.edu.au/)