COURSE STAFF

Course Convener: A/Prof. Toan Phung, Room 123, Elec. Eng. Building G17, toan.phung@unsw.edu.au

Consultations: You are encouraged to ask questions on the course material, during or immediately after the lecture class times in the first instance, rather than via email. Students may seek consultation with the course convener at other times by appointment. ALL email enquiries should be made from your university email address with ELEC9712 in the subject line; otherwise they will not be answered.

Keeping Informed: Announcements may be made during classes, via email (to your student email address) and/or via online learning and teaching platform Moodle https://moodle.telt.unsw.edu.au/login/index.php. Please note that you will be deemed to have received this information, so you should take careful note of all announcements.

COURSE SUMMARY

Contact Hours
The course consists of regular 3 contact hours per week for lectures. However, occasional extra time immediately after the lecture class or at other times during the term is for tutorials, tests or other teaching activities.

<table>
<thead>
<tr>
<th>Day</th>
<th>Time</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class time</td>
<td>Wednesday</td>
<td>6-9 pm</td>
</tr>
</tbody>
</table>

Context
Power Engineering is concerned with the generation, transmission, distribution and utilization of electrical energy. Large power systems are interconnected physical networks of many different types of equipment and apparatus: synchronous generators for generating electricity, power transformers for changing the voltage levels, overhead transmission lines, underground cables, metering and control equipment, switchgear for connection/disconnection, high-voltage insulators, etc. Each equipment type in turn comprises many different designs to suit different electrical operating conditions (voltage, current and power levels) and ambient constraints.

Aims
High voltage engineering and technology form an important area in power engineering. It deals mainly with electrical insulation systems and processes that take place in power system equipment. In-depth knowledge in this area is essential for designers and operators of high voltage equipment and power utility engineers. The course aims to provide students with essential knowledge in the technology and testing techniques for high voltage power system components and equipment. Particular emphasis is on current practices within Australian power utilities.
### Indicative Lecture Schedule

<table>
<thead>
<tr>
<th>Period</th>
<th>Summary of Lecture Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1-2</td>
<td>Coverage of fundamental materials common to the design and operation principles of electrical power equipment. Topics include: Fields and materials, power loss generation, electro-dynamic force calculations, thermal behaviour and ratings calculations, electrical contact behaviour.</td>
</tr>
<tr>
<td>Week 3-4</td>
<td>Transmission/Distribution Lines and Cables Overhead lines, cables, gas insulated systems and busbars. Design and operation. Transient ratings. Electric and Magnetic Fields and their effect on design and operation. Sag and tension of OH lines, insulation aspects. GIS design and operation.</td>
</tr>
<tr>
<td>Week 5</td>
<td>High voltage circuit breaker and surge arrester design Arc properties. Design principles for low and medium voltage devices. Switching transients and their effects and control. Switchboard arcing effects. Testing. Diagnostic and monitoring techniques for switchgear. <strong>Mid-term exam</strong></td>
</tr>
<tr>
<td>Week 6</td>
<td>Insulating Materials Solid, liquid, and gaseous insulation materials used in high voltage equipment. Physics of electrical breakdowns. Outdoor insulators</td>
</tr>
<tr>
<td>Week 7</td>
<td>Power transformers Design principles and operation. Insulation requirements and types. Cyclic rating determination. Instrument Transformers - Voltage and Current Design, Accuracy and applications. Modern VTs and CTs. Frequency response</td>
</tr>
<tr>
<td>Week 8-9</td>
<td>Modern Condition Monitoring techniques Generation and measurement of high voltage (AC, DC, impulse). High voltage testing of power system equipment (according to Standards). On-line versus off-line testing techniques. Life assessment of equipment. Reliability.</td>
</tr>
<tr>
<td>Week 10</td>
<td><strong>Group Assignment Presentation</strong></td>
</tr>
</tbody>
</table>

The above schedule is provisional and may be updated during the term. You should attend lectures and regularly check the course website for possible updates.

### Assessment

- **Mid-Term Exam (week 5)** 25%
- **Group Assignment – presentation and report (week 10)** 15%
- **Final Exam (2 hours, during exam period, TBA)** 60%

There will be opportunities to earn bonus marks through activities in the classroom or through other media. Note that you may have to pass the final exam to pass the course.
Important Health Related Notice
Your health and the health of those in your class is critically important. You must stay at home if you are sick or have been advised to self-isolate by NSW health or government authorities. Current alerts and a list of hotspots can be found here. You will not be penalised for missing a face-to-face activity due to illness or a requirement to self-isolate. We will work with you to ensure continuity of learning during your isolation and have plans in place for you to catch up on any content or learning activities you may miss. Where this might not be possible, an application for fee remission may be discussed.

If you are required to self-isolate and/or need emotional or financial support, please contact the Nucleus: Student Hub. If you are unable to complete an assessment, or attend a class with an attendance or participation requirement, please let your teacher know and apply for special consideration through the Special Consideration portal. To advise the University of a positive COVID-19 test result or if you suspect you have COVID-19 and are being tested, please fill in this form.

UNSW requires all staff and students to follow NSW Health advice. Any failure to act in accordance with that advice may amount to a breach of the Student Code of Conduct. Please refer to the Safe Return to Campus guide for students for more information on safe practices.

COURSE DETAILS

Credits
This is a 6 UoC postgraduate course in the power engineering discipline. The expected workload is 15 hours per week throughout the 10-week term.

Relationship to Other Courses
This is one of the specialization courses for a Master degree in Engineering or Engineering Science (Energy Systems) at UNSW. Some of the topics in this course are covered at an introductory level in ELEC4611 (an undergraduate elective course).

Pre-requisites and Assumed Knowledge
It is assumed that the students have completed all the core courses (or their equivalents) required in the first 3 years of a BEE degree, and in particular ELEC3105 (Electrical Energy). Also, it is recommended that you are familiar with ELEC4611 (Power System Equipment) before this course is attempted. It is further assumed that students have good computer literacy such as Matlab programming.

Learning outcomes
After successful completion of this course, you should be able to:

1. Have detailed knowledge of the various types of insulating materials (gaseous, liquids, solids, vacuum, composites) and their applications in high-voltage equipment.
2. Use analysis methods to calculate electric stress, magnetic field, mechanical and thermal aspects associated with high voltage high power equipment and their application in the design of high-voltage components.
3. Understand practical techniques to generate and measure high-voltages (DC, AC, impulse).
4. Have detailed knowledge of the various types of electrical/physical/chemical diagnostic measurements for insulation assessment; in particular partial discharge detection, measurement, and characterization.

This course is designed to provide the above learning outcomes which arise from targeted graduate capabilities listed in Appendix A. The targeted graduate capabilities broadly support the UNSW and Faculty of Engineering graduate capabilities (listed in Appendix B). This course also addresses the Engineers Australia (National Accreditation Body) Stage I competency standard as outlined in Appendix C.

Syllabus
This course provides a detailed coverage of the common features of major items of high voltage equipment and components, including materials used and dielectric properties; field analysis and its use in determining the electrical insulation design; thermal ratings of equipment; the design of both static and dynamic contact systems for equipment; the design and operation of specific items of equipment including transformers (power and
instrument), switchgear, cables, overhead lines, surge arresters; techniques to generate and measure high
voltages; condition monitoring and high-voltage diagnostic testing methods.

TEACHING STRATEGIES

Delivery Mode
The teaching in this course aims at establishing a good fundamental understanding of the areas covered using:

- Formal face-to-face lectures, which provide you with a focus on the core analytical material in the course,
together with qualitative, alternative explanations to aid your understanding;
- Tutorials, which allow for exercises in problem solving and allow time for you to resolve problems in
understanding of lecture material;
- Blended learning via Moodle;
- Guest lectures from professionals and industry experts offering practical experience and knowledge;

Learning in this course
You are expected to attend all lectures, tutorials, and mid-term exams in order to maximize learning. In addition to
the lecture notes/video, you should read relevant sections of the recommended text. Reading additional texts will
further enhance your learning experience. Group learning is also encouraged. UNSW assumes that self-directed
study of this kind is undertaken in addition to attending face-to-face classes throughout the course.

Prior to attending the lectures, students are expected to prepare themselves for them. The lectures provide the
students with a focus on the core material in the course. Generic features and functions of various types of major
equipment and apparatus required 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 operation of power system
equipment. This in turn leads students to an appreciation of the equipment ratings, choice of particular insulation
materials and designs. The basic principles covering the high-voltage testing and condition monitoring of
equipment are presented and then illustrated by examining a wide array of diagnostic devices that are currently
being used in the power industry.

The tutorial sessions provide personal assistance to students in solving problems. A total of 4 problem sets will
be presented throughout the term 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.

ASSESSMENT

The assessment scheme in this course reflects the intention to assess your learning progress through the term.

Mid-Term Exam
The mid-term examination tests your general understanding of the course material, and is designed to give you
feedback on your progress through the analytical components of the course. Questions may be drawn from any
course material covered thus far. The questions can be numerical calculations, analytical or conceptual. Marks
will be assigned according to the correctness of the responses.

Group Assignment
This is a group project whereby each group is to carry out an engineering investigation (problem formulation,
literature review, methodologies, simulations, analysis) on a topic relevant to this course, and submit a detailed
written report together with an oral presentation. The assessment criteria aim to evaluate your research and
communication skills. Submission is due at the end of week 10. Late submissions carry a 50% penalty for the first
week and will not be accepted beyond that.
Final Exam
The exam in this course is a standard 2-hour written examination, covering all aspects of the course that have been presented in the lectures and tutorials. The exam format will be similar to previous years’ examinations. Some questions are of a descriptive nature (e.g. explaining a concept) and the rest are problem-solving. University approved calculators are allowed. The examination tests analytical and critical thinking and general understanding of the course material in a controlled fashion. Assessment is a graded mark according to the correct fraction of the answers to the exam questions.

Relationship of Assessment Methods to Learning Outcomes

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Learning outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid-term exam</td>
<td>1 2</td>
</tr>
<tr>
<td>Assignment</td>
<td>1 2</td>
</tr>
<tr>
<td>Final exam</td>
<td>1 2</td>
</tr>
</tbody>
</table>

COURSE RESOURCES

Recommended text(s)

There are no prescribed textbooks for the course. A comprehensive set of lecture notes developed by the convener are made available for download from the course website.

The following references will each cover parts of the course only. They are listed in no particular order of importance although the ones in bold are perhaps those most relevant:

On-line resources

Moodle
The course website is on UNSW Moodle: https://moodle.telt.unsw.edu.au/login/index.php. It contains lecture notes, tutorials, sample exam papers, as well as other relevant information and announcements about this course.

Mailing list
Announcements concerning course information will be given in the lectures and/or on Moodle and/or via email (which will be sent to your student email address).

OTHER MATTERS

Dates to note
Important dates available at: https://student.unsw.edu.au/dates

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 form of academic misconduct, and the University has very strict rules that include some severe penalties. For UNSW policies, penalties and information to help you avoid plagiarism, see https://student.unsw.edu.au/plagiarism. To find out if you understand plagiarism correctly, try this short quiz: https://student.unsw.edu.au/plagiarism-quiz.

Student Responsibilities and Conduct
Students are expected to be familiar with and adhere to all UNSW policies (see https://student.unsw.edu.au/policy), and particular attention is drawn to the following:

Workload
It is expected that you will spend at least **15 hours per week** studying a 6 UoC course, from Week 1 until the final assessment, including both face-to-face classes and *independent, self-directed study*. In periods where you need to complete assignments or prepare for examinations, the workload may be greater. Over-commitment has been a common source of failure for many students. You should take the required workload into account when planning how to balance study with employment and other activities.

Attendance
Regular and punctual attendance at all classes is expected. UNSW regulations state that if students attend less than 80% of scheduled classes they may be refused final assessment.

General Conduct and Behaviour
Consideration and respect for the needs of your fellow students and teaching staff is an expectation. Conduct which unduly disrupts or interferes with a class is not acceptable and students may be asked to leave the class.

Work Health and Safety
UNSW policy requires each person to work safely and responsibly, in order to avoid personal injury and to protect the safety of others.

Special Consideration and Supplementary Examinations
You must submit all assignments and attend all examinations scheduled for your course. You can apply for special consideration when illness or other circumstances beyond your control interfere with an assessment performance. If you need to submit an application for special consideration for an exam or assessment, you must submit the application **prior to the start** of the exam or before the assessment is submitted, except where illness or misadventure prevent you from doing so. Be aware of the “fit to sit/submit” rule which means that if you sit an exam or submit an assignment, you are declaring yourself well enough to do so and cannot later apply for Special Consideration. For more information and how to apply, see https://student.unsw.edu.au/special-consideration
Continual Course Improvement
This course is under constant revision in order to improve the learning outcomes for all students. Please forward any feedback (positive or negative) on the course to the course convener or via the online student survey myExperience. You can also provide feedback to ELSOC who will raise your concerns at student focus group meetings. As a result of previous feedback obtained for this course and in our efforts to provide a rich and meaningful learning experience, we have continued to evaluate and modify our delivery and assessment methods.

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 and UNSW policies: https://student.unsw.edu.au/guide
https://www.engineering.unsw.edu.au/electrical-engineering/resources

APPENDICES

Appendix A: Targeted Graduate Capabilities
Electrical Engineering and Telecommunications programs are designed to address the following targeted capabilities which were developed by the School in conjunction with the requirements of professional and industry bodies:

- The ability to apply knowledge of basic science and fundamental technologies;
- The skills to communicate effectively, not only with engineers but also with the wider community;
- The capability to undertake challenging analysis and design problems and find optimal solutions;
- Expertise in decomposing a problem into its constituent parts, and in defining the scope of each part;
- A working knowledge of how to locate required information and use information resources to their maximum advantage;
- Proficiency in developing and implementing project plans, investigating alternative solutions, and critically evaluating differing strategies;
- An understanding of the social, cultural and global responsibilities of the professional engineer;
- The ability to work effectively as an individual or in a team;
- An understanding of professional and ethical responsibilities;
- The ability to engage in lifelong independent and reflective learning.

Appendix B: UNSW Graduate Capabilities
The course delivery methods and course content directly or indirectly addresses a number of core UNSW graduate capabilities, as follows:

- Developing scholars who have in-depth knowledge and understanding of their discipline through the lectures.
- Development of analytical and critical thinking, which is addressed by the tutorial exercises, test, and final examination.
- Developing digital and information literacy and lifelong learning skills - the skills to appropriately locate, evaluate and use relevant information.
- The ability to engage in independent and reflective learning (via project assignment).
- Development of effective communication (oral presentation and written report).
- Team and collaborative working skills (via group project assignment).
### Appendix C: Engineers Australia (EA) Professional Engineer Competency Standard

<table>
<thead>
<tr>
<th>Program Intended Learning Outcomes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PE1: Knowledge and Skill Base</strong></td>
<td></td>
</tr>
<tr>
<td>PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals</td>
<td>✓</td>
</tr>
<tr>
<td>PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing</td>
<td>✓</td>
</tr>
<tr>
<td>PE1.3 In-depth understanding of specialist bodies of knowledge</td>
<td>✓</td>
</tr>
<tr>
<td>PE1.4 Discernment of knowledge development and research directions</td>
<td>✓</td>
</tr>
<tr>
<td>PE1.5 Knowledge of engineering design practice</td>
<td>✓</td>
</tr>
<tr>
<td>PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice</td>
<td></td>
</tr>
<tr>
<td><strong>PE2: Engineering Application Ability</strong></td>
<td></td>
</tr>
<tr>
<td>PE2.1 Application of established engineering methods to complex problem solving</td>
<td>✓</td>
</tr>
<tr>
<td>PE2.2 Fluent application of engineering techniques, tools and resources</td>
<td>✓</td>
</tr>
<tr>
<td>PE2.3 Application of systematic engineering synthesis and design processes</td>
<td></td>
</tr>
<tr>
<td>PE2.4 Application of systematic approaches to the conduct and management of engineering projects</td>
<td></td>
</tr>
<tr>
<td><strong>PE3: Professional and Personal Attributes</strong></td>
<td></td>
</tr>
<tr>
<td>PE3.1 Ethical conduct and professional accountability</td>
<td></td>
</tr>
<tr>
<td>PE3.2 Effective oral and written communication (professional and lay domains)</td>
<td>✓</td>
</tr>
<tr>
<td>PE3.3 Creative, innovative and pro-active demeanour</td>
<td></td>
</tr>
<tr>
<td>PE3.4 Professional use and management of information</td>
<td>✓</td>
</tr>
<tr>
<td>PE3.5 Orderly management of self, and professional conduct</td>
<td>✓</td>
</tr>
<tr>
<td>PE3.6 Effective team membership and team leadership</td>
<td>✓</td>
</tr>
</tbody>
</table>