School of Electrical Engineering and Telecommunications

Term 3, 2019
Course Outline

ELEC3111
Distributed Energy Generation

COURSE STAFF

Course Convener: Dr. Ke Meng, Room 306, Electrical Engineering Building (G17) (Click here for the map), ke.meng@unsw.edu.au

Tutor: Dr. Bin Liu, Room 326, Tyree Energy Technologies Building (H6) (Click here for the map), bin.liu@unsw.edu.au

Consultations: You are encouraged to ask questions on the course material, after the lecture class times in the first instance, rather than via email. Lecturer consultation times will be advised on Moodle, https://moodle.telt.unsw.edu.au/login/index.php, which is an online learning and teaching management platform used in this course. You can also post questions on Moodle discussion forums (highly encouraged). Questions regarding course logistics should be made to the course conveners. Otherwise, consultation times regarding course content questions can be organized by email. ALL email enquiries should be made from your student email address with "**ELEC3111**" in the subject line; otherwise they may not be answered.

Keeping Informed: All announcements regarding the course and its assignments will be made via Moodle. Announcements may also be made during classes, but everything will be formally posted on the "Course Announcements" forum of ELEC3111 in Moodle. 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:

- Lecture: 4 hours every week (2 sessions);
- Tutorial (face-to-face): 2 hours every week, starting from **Week 2**;

Sessions	Day	Time	Location
Lectures	Wednesday	4pm - 6pm	AinswthG02
	Friday (weeks 1-6)	10am - 12noon	
	Friday (weeks 7-10)	10am - 11am	
Tutorials	Friday	12noon - 2pm	

Context and Aims

Distributed energy generation is developing into a significant market in the generation, distribution and utilization of electrical energy. It includes local fossil-fuel derived energy sources, for example, co-generation from natural gas, renewable energy sources, such as wind and hydro, and low-carbon hybrid energy systems that combine energy sources from more than one energy source, whether renewable or fossil-fueled. This course will equip you with the fundamental technical and economic processes and drivers at play in the electrical power industry.

Issues that will be covered include the basics of distribution network modelling, the different types of distributed energy sources utilized (Co-generation/CHP, wind, hydro, photovoltaics) and where they are integrated onto the electrical grid, the impact of the integration of such sources on the fundamental operation of the distribution and transmission networks, and how distributed generation is impacting on the development and operation of market frameworks.

The material will be presented by a team of leading researchers in each of these key areas for distributed generation. The indicative lecture schedule is noted below, although note that it remains subject to change.

The aims of the course are to:

- Provide students with analytical and practical design experience;
- Ensure the students' design skills are adequate and to the level desirable for a professional Engineer;
- Give the students the opportunity to improve their design skills and engineering practice skills required by professional engineers.

Indicative Lecture Schedule

In a typical term, each topic will be delivered in one week as shown below,

Period	Summary of Lecture Program
Week 01	Introduction to modern electric power distribution systems
Week 02	Active network and system integration of variable generation
Week 03	Modelling of power distribution systems, Volt-Var planning and control
Week 04	Overview of distributed generation technologies and applications
Week 05	Modelling and analysis of distributed solar PV generation
Week 06	Modelling and analysis of distributed wind generation
Week 07	Design concepts of microgrids
Week 08	Energy storage technologies, applications and integration
Week 09	Unbalanced distribution systems analysis
Week 10	Big data analytics in electric power distribution systems

Assessment

The following summative assessment tasks will give you your final mark for Term 3, 2019.
It should be noted that because of changes in UNSW's Assessment policy the length of the final exam has been reduced to two hours.

Assignment Work (3 assignments)	40%
Final Exam (2 hours)	60%
Total	100%

- The date of the final exam will be announced by the University.
- All assignments should be submitted through Turnitin on Moodle or the other ways approved by the convener.
- Unless with a valid reason (such as a medical certificate) late submission will be penalized by 20% for each day late for up to a maximum 60%. Late submission after the 3rd day will not be accepted.

For further details on each assessment task and their marks please refer to Page 6 of this document.

COURSE DETAILS

Credits

ELEC3111 is 6 UOC course. The expected average workload is approximately **16 hours per week** throughout the 10-week term, including face-to-face contact hours and self-studying.

Relationship to Other Courses

This is a 3rd year undergraduate elective course in the School of Electrical Engineering and Telecommunications. It is an elective course for students following a BE (Electrical) or (Telecommunications) program and other combined degree programs.

Pre-requisites and Assumed Knowledge

The pre-requisite for this course is ELEC2134. It is essential that you are familiar with AC and DC circuit analysis and the concepts of real and reactive power before this course is attempted.

Learning outcomes

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

LO1. Describe and explain the basic operation, control and modelling of distributed energy systems.
LO2. Describe the basic components of a range of distributed energy sources including wind, PV, hydro, co-generation, and energy storage systems.
LO3. Describe and demonstrate through calculation the impacts that distributed energy sources are having on the control and operation of electrical networks including voltage control, power factor, power quality.
LO4. Describe the basic operation of a power electronics inverter and its interface to an electrical network and perform basic calculations.
LO5. Describe and understand HVDC systems and their advantages and disadvantages.
LO6. Describe the operation of electrical energy markets and the role distributed and intermittent energy sources play in the marketplace.
LO7. Describe how demand-side management alters the operation of energy markets.
LO8. Identify and demonstrate an understanding of applicable standards and grid codes.
LO9. Understand and describe common components found in intelligent networks including telecoms, power electronics, sensing and measurement.
LO10. Appreciate the key role that the smart grid will play in facilitating distributed generation.

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

- The capacity for analytical and critical thinking and for creative problem solving;
- The ability to engage in independent and reflective learning;
- Information Literacy – the skills to locate, evaluate, and use relevant information;
- The capacity for enterprise, initiative, and creativity;
- The skills of effective communication.

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***.

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.

Learning in this course

You are expected to attend all lectures and tutorials in order to maximise learning. In addition to your lecture notes, 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.

Tutorial classes

You should attempt all of your problem sheet questions in advance of attending the tutorial classes. The importance of adequate preparation prior to each tutorial cannot be overemphasized, as the effectiveness and usefulness of the tutorial depends to a large extent on this preparation. Group learning is encouraged. Answers for these questions will be discussed during the tutorial class and the tutor will cover the more complex questions in the tutorial class. In addition, during the tutorial class, 1-2 new questions that are not in your notes may be provided by the tutor, for you to try in class. These questions and solutions may not be made available on the web, so it is worthwhile for you to attend your tutorial classes to gain maximum benefit from this course.

ASSESSMENT

The assessment scheme in this course reflects the intention to assess your learning progress through the semester. Ongoing assessment occurs through the assignment work.

Assignment

The assignments allow self-directed study leading to the solution of partly structured problems. Marks are assigned according to how completely and correctly the problems have been addressed, and the understanding of the course material evident in the submission.

Late submissions will attract a penalty of 10% per day (including weekends). Assignment submissions are to be made via Moodle. You must include a signed cover sheet

(see http://scoff.ee.unsw.edu.au/forms/assignmentcover.pdf)

declaring that the work submitted is your own work and this must be the first page of the report

Final Exam

The exam in this course is a standard closed-book two hour written examination, comprising four compulsory questions. University approved calculators are allowed. The examination tests analytical and critical thinking and general understanding of the course material in a controlled fashion. Questions may be drawn from any aspect of the course (including tutorials), unless specifically indicated otherwise by the lecturer. Marks will be assigned according to the correctness of the responses. *Please note that you must pass the final exam in order to pass the course.*

Relationship of Assessment Methods to Learning Outcomes

	Learning outcomes							
Assessment	**LO1-2**	**LO3-4**	**LO5**	**LO6**	**LO7**	**LO8**	**LO9**	**LO10**
Assignment	✓	✓	✓	✓	✓	✓	-	-
Final exam	✓	✓	✓	✓	✓	✓	✓	✓

COURSE RESOURCES

Textbooks

Reference books: The following textbooks are recommended reading:

- Mohan, Undeland, Robbins, 'Power Electronics: Converters, Applications, and Design', Wiley, 3rd Edition, ISBN 978-0471226932
- Fox, et. al., 'Wind Power Integration: Connection and System Operational Aspects (Power & Energy)', IET, ISBN 978-0863414497
- Kirschen, Strbac, 'Fundamentals of Power System Economics', Wiley, ISBN 978-0-470-84572-1, available online from the UNSW library
- Bollen, Hassan, 'Integration of Distributed Generation in the Power System', IEEE publication, available online from the UNSW library
- Chapter 4 in the book titled "Design of smart power grid renewable energy systems", by Ali Keyhani, Wiley, 2011.
- Chapters 31 and 32 in the book titled "Power Electronics Handbook - Devices, Circuits, and Applications", 3rd Edition, by Rashid, Muhammad H., 2011.
- Paper: "Loss evaluation of HVAC and HVDC transmission solutions for large offshore wind farms", N. Barberis Negra, J. Todorovic , T. Ackermann, Electric Power Systems Research 76 (2006) 916–927.

On-line resources

Moodle

As a part of the teaching component, the online teaching and learning management system known as Moodle will be used to disseminate teaching materials, host forums and quizzes. As the course progresses, students' marks from assessments such as labs and the quizzes are available for personal viewing on this website:

https://moodle.telt.unsw.edu.au/login/index.php.

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/guide), and particular attention is drawn to the following:

Workload

It is expected that you will spend at least **twelve to sixteen 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 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 should seek assistance early if you suffer illness or misadventure which affects your course progress. All applications for special consideration must be **lodged online through myUNSW within 3 working days of the assessment**, not to course or school staff. For more detail, consult 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 address a number of core UNSW graduate capabilities, as follows

- Developing scholars who have a deep understanding of their discipline, through lectures and solution of analytical problems in tutorials and assessed by assignments and written examinations.
- Developing rigorous analysis, critique, and reflection, and ability to apply knowledge and skills to solving problems. These will be achieved by the laboratory experiments and interactive checkpoint assessments and lab exams during the labs.
- Developing capable independent and collaborative enquiry, through a series of tutorials spanning the duration of the course.
- Developing digital and information literacy and lifelong learning skills through assignment work.
- Developing ethical practitioners who are collaborative and effective team workers, through group activities, seminars and tutorials.
- Developing independent, self-directed professionals who are enterprising, innovative, creative and responsive to change, through challenging design and project tasks.
- Developing citizens who can apply their discipline in other contexts, are culturally aware and environmentally responsible, through interdisciplinary tasks, seminars and group activities.

Appendix C: Engineers Australia (EA) Professional Engineer Competency Standard

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