ELEC3111
DISTRIBUTED ENERGY GENERATION

Course Outline – Semester 1, 2016

Never Stand Still | Faculty of Engineering | School of Electrical Engineering and Telecommunications

Course Staff

Course Convener: Iain MacGill, Room TETB 316, i.macgill@unsw.edu.au.

Lecturers: Prof. John Fletcher, j.fletcher@unsw.edu.au
Dr. Daming Zhang, daming.zhang@unsw.edu.au
A/Prof Iain MacGill, i.macgill@unsw.edu.au

Consultations: You are encouraged to ask questions on the course material, during or after the lecture class times in the first instance, rather than via email. Questions regarding course logistics should be made to the course convener, Iain MacGill. Otherwise, consultation times regarding course content questions can be organized by email with the relevant lecturer. ALL email enquiries should be made from your student email address with ELEC3111 in the subject line to the relevant lecturer, 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 platforms – in this course, we will use 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 2-3 hours of lectures and a 1-2 hour tutorial (tutorials start week 2).

Lectures	Day	Time	Location
Running weeks 1 - 12	Tuesday	10am – 11 am	Central Lecture Block 4 (K-E19-G05)
	Wednesday	3pm - 5pm	Mathews Theatre D (K-D23-304)
Tutorial Running weeks 2-13	Monday	12 midday – 2pm	Red Centre Central Wing M032 (K-H13-MO32)

Context and Aims

Distributed energy generation is developing into a significant market in the generation, distribution and utilisation of electrical energy. It includes local fossil-fuel derived energy sources, for example, co-generation from LNG, 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-fuelled. 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 utilised (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.

Indicative Lecture Schedule and Syllabus

Week	Staff	Topic	Comments
1	JF	Overview of Power Systems and Distributed Generation Systems	
2	JF	Basic models of distribution systems	
3	JF	Introduction to distributed energy sources	Assign 1 out (10%)
4	JF	Power system control: single- and three-phase systems, per-unit system	
5	JF	Issues related to bidirectional power flow on networks: voltage control, system protection	
6	JF	The basic inverter and interfacing, real and reactive control	Assignment 1 due Assignment 2 out (10%)
7	DZ	'Smart' grid concepts	
8	DZ	'Smart' grid concepts	
9	DZ	HVDC v's HVAC networks: offshore and onshore applications	Assignment 2 due Assignment 3 out (10%)
10	IM	The energy market: energy pools, bidding, clearing, unit commitment	
11	IM	The energy market: balancing , capacity and ancillary services	
12	IM	The energy market: demand-side management	Assignment 3 due
			Final exam (70%)

JF – Prof John Fletcher DZ – Dr Daming Zhang
IM – A/Prof Iain MacGill

Assessment

Students will be assessed according to the following scheme (subject to change):
Final Examination 70% of total
Assignment work (3 assignments/tests) 30% of total

Course Details

Credits

This is a 6 UoC course and the expected workload is 10–12 hours per week throughout the 13 week semester.

Relationship to Other Courses

This is a Third 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, and an elective for SPREE students.

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:

1. Describe and explain the basic operation, control and modelling of distributed energy systems.
2. Describe the basic components of a range of distributed energy sources including wind, PV, hydro, cogeneration, and energy storage systems.
3. Describe the operation of electrical energy markets and the role distributed and intermittent energy sources play in the marketplace.
4. Describe how demand-side management alters the operation of energy markets.
5. 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.
6. Describe the basic operation of a power electronics inverter and its interface to an electrical network and perform basic calculations.
7. Understand and describe common components found in intelligent networks including telecoms, power electronics, sensing and measurement.
8. Describe and understand HVDC systems and their advantages and disadvantages.
9. Identify and demonstrate an understanding of applicable standards and grid codes.

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 will be assigned according to how completely and correctly the problems have been addressed, and the understanding of the course material demonstrated by the submission.

Late submissions will attract a penalty of 10% per day (including weekends). Assignment submissions are to be made via the school office. You must include a signed cover sheet 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 3 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 laboratory), 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	**1-2**	**3-4**	**5**	**6**	**7**	**8**	**9**
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, Moodle will be used to disseminate teaching materials. Assessment marks will also be made available via Moodle: https://moodle.telt.unsw.edu.au/login/index.php.

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

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 http://www.lc.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://my.unsw.edu.au/student/atoz/ABC.html), and particular attention is drawn to the following:

Workload

It is expected that you will spend at least **ten to twelve 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://my.unsw.edu.au/student/atoz/SpecialConsideration.html.

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 Course and Teaching Evaluation and Improvement Process. 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. For example, this course has undergone changes to staff numbers delivering the course.

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:
http://www.engineering.unsw.edu.au/electrical-engineering/policies-and-procedures
https://my.unsw.edu.au/student/atoz/ABC.html

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 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 through assignment work.
- Developing capable independent and collaborative enquiry, through a series of tutorials spanning the duration of the course.

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	