

## Course Staff

The course coordinator and lecturer is:

**Dr Iain MacGill**

Joint Director (Engineering), Centre for Energy and Environmental Markets (CEEM)

Associate Professor, School of Electrical Engineering and Telecommunications.

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It is intended that several guest lectures will also be arranged with research and industry experts during the session.

**Consultations:** You are, of course, encouraged to ask questions on the course material during the lectures. Iain will be available for additional consultation on the lectures, assignments and projects before, during and after lectures, or by appointment (arranged at lectures or by email). Please note that he is unlikely to be available for consultations without an appointment.

Scheduled lecturer consultation times for the assignments and projects will be advised during lectures, and on moodle. Note that ALL email enquiries should be made from your student email address with ELEC9715 mentioned in the subject line, otherwise they will not be answered.

## Course Details

### Credits

This is a 6 UoC course and the expected workload is 10–12 hours per week throughout the 13 week semester. As noted below, most of this time must be self-directed learning.

### Contact Hours

As a post-graduate offering, the course consists of 3 hours of lectures each week from weeks 1 to 11. Weeks 12 and 13 will involve student seminar presentations in the same room. It is possible that there will be a one week in this period where no lecture will be held subject to travel commitments of the lecturer – note, however, that at a minimum there will be 12 weeks of class in total. There are no tutorials or laboratories. The last hour of some lectures may be run in a tutorial format to assist with the assignments and consultation periods prior to the submission of assignments will be offered – further details will be provided over the semester. The provisional syllabus of these weekly lectures is outlined below.

Lectures	Day	Time	Location
	Thursday	6-9pm	Electrical Engineering Building Rm224

### Context and Aims

The purpose of this course is to introduce students to the main issues involved in electricity industry operation and control – that is, decision making approaches and methods to meet industry objectives through appropriate operation of existing power system equipment. Industry operation and control will be discussed in the context of both traditional monopoly utility run power systems and the restructured market-based industries now becoming more common worldwide. Thus the course will explore the broader issue of electricity industry operation and control rather than the narrower traditional power system focus.

Furthermore, it will also explore the challenges and opportunities that distributed energy resources – generation, storage and demand-side participation – bring to electricity industry operation.

Considerable attention is given to practical implementation and experience to date in Australia, with comments on other countries when appropriate. Students taking this course will therefore gain a critical appreciation of the operation of Australia's restructured industry, and the emerging opportunities and challenges that the industry faces.

### **Relationship to Other Courses**

This is a postgraduate course in the School of Electrical Engineering and Telecommunications. The course is available in the following programs: Master of Engineering Science; Doctor of Philosophy in Engineering, Master of Engineering and Bachelor of Engineering (4th Year Elective substitution). Students undertaking other courses may also be permitted subject to agreement with the School of Electrical Engineering and Telecommunications, and the Course Coordinator.

The companion course, ELEC9714 Electricity Industry Planning and Economics explores issues of electricity industry structure, market design and technical, economic and environmental regulation with a particular focus on the investment decision making timescale.

### **Pre-requisites and Assumed Knowledge**

Although this subject has no formal prerequisites, it is assumed that each student has a basic working knowledge of power systems. A number of texts are available for students whose undergraduate training did not include this type of material, or who feel that they require revision. Please contact the lecturer to discuss if you have questions regarding this matter.

It is further assumed that students are familiar with Standard Office software tools including Excel, Word and Powerpoint (or equivalents).

### **Following Courses**

The course is not a pre-requisite for other courses at UNSW. However, it does have close links to its companion course, ELEC9714 Electricity Industry Planning and Economics. There is some cross-over between the two courses, but they are also carefully designed to complement each other whilst not requiring that you take them in sequence, or necessarily take both of them.

### **Learning outcomes**

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

1. Understand the fundamental objectives, constraints and concepts of electricity industry operation and control
2. apply basic conventional economic dispatch, unit commitment, hydro-scheduling, production costing, reliability assessment and operation planning techniques to simple electricity industry problems
3. describe the implementation of power system operation and control in a restructured industry context including ancillary services, and energy spot and derivative markets
4. apply basic models for electricity markets to simple restructured electricity industry problems
5. appreciate how electricity industry restructuring, technology development and environmental concerns are changing the way in which power system operation and control is defined and undertaken
6. describe the opportunities and challenges that emerging distributed energy resources pose for future electricity industry operation and control

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 attributes (listed in *Appendix B*). This course also addresses the Engineers Australia (National Accreditation Body) Stage I competency standard as outlined in *Appendix C*.

## Syllabus

Introduction to the evolving electricity industry drivers of restructuring, technological developments and environmental concerns, and their impact on power system operation. Conventional approaches and tools for economic dispatch, unit commitment, hydroscheduling, production costing, reliability measures and operations planning in traditional industry structures. Power system operation within restructured electricity industries-wholesale spot electricity markets, bilateral trading, forward markets and full retail competition. Operation of power systems with renewable energy resources

## 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;
- A number of guest lectures from industry and research experts
- Small periodic quizzes (non-assessed)

### Learning in this course

You are expected to attend all lectures in order to maximise learning. In addition to the lecture notes, you should read relevant sections of any recommended texts. Reading additional texts and reports 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.

Lectures will make extensive use of PowerPoint slides and white board work. PowerPoint printouts will be provided at the start of lectures if and when possible, and placed on the course Moodle website. Additional information and reading materials will also be progressively made available on Moodle, but they are no substitute for accurate notes, and active student participation through questions and informal exercises during the lectures. It is also intended that you will be provided with access to a number of on-line data sources for the Australian National Electricity Market including a powerful market tool - *NEM Sight*.

### Indicative Lecture Schedule

Note that this schedule is provisional at this stage and may be updated during the session. You should attend lectures and regularly check the course Moodle website for possible updates. Note that there may be tasks (non-assessable) to undertake on Moodle each week as well – be sure to keep up to date with developments. A number of guest lectures are also intended to be included in the second half of semester.

WEEK	LECTURE	Class tasks	
1	Introduction; important features and attributes of the electricity industry; definition of the key problems and challenges of industry operation and control.	Introductions. Student survey.	
2	Key technologies for generation, networks, loads and their control capabilities	[out] Assignment 1	
3	Technology operational characteristics Decision making tools Economic dispatch (utilisation of operating generators & loads)	[out] information on group projects and possible topics	
4	Continuous voltage and frequency control	[in] Assignment 1	
5	Contingencies and their management	[in] preliminary group topic preferences [out] Assignment 2	
6	Unit commitment (selection of generators & loads to operate)	group project topics finalized by end week 6	
7	Energy constraints: hydro, fuel management and maintenance scheduling	[in] Assignment 2	
8	The operational challenges of distributed energy resources	Mid semester quiz	
9	Operation and control issues associated with intermittent generation	[out] Assignment 3 Project progress reviews	
10	Electricity industry operation in a carbon constrained future	[in] Assignment 3	
11	Electricity industry operation in a 'smart grid'	[out] Exam prep. guidance and sample questions	
12	Student group presentations	Seminar ppt to be uploaded into Moodle by 6pm on evening of presentation	
13	Student group presentations	Group reports due end week 13	

## Assessment

The assessment scheme in this course reflects the intention to assess your learning progress through the semester. Assessment will consist of a group report on an agreed topic related to material covered in the course; a group oral presentation to the class of the major points in the report, class assignments taken individually, a mid-semester quiz and the final exam. Satisfactory performance in both the class based assessment and examination is required to pass this course. The assigned marks for each assessment component are as follows:

Assessment activity	Assessment (%)
Group student project reports on a topic agreed with the course coordinator by week 6 lecture (submission prior to the end of week 13)	25 in total (2/3 report, 1/3 seminar)
Group student presentations on their report topics (over weeks 12-13 in a student order determined by the course coordinator)	
Mid semester quiz (1 hour)	10
Individual student assignments during the semester (number and submission dates to be confirmed within the course lectures).	15
Final exam (2 hours)	50

### Assignment

The assignment allows 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 report.

These assignments must be undertaken by students individually. It is expected that there will be three such assignments during the semester. Provisional dates for assignment distribution and submission are provided in the course syllabus.

### Project report and seminar

The project will involve students in an activity suited to their interests and skills in the area of electricity industry operation and control. Groups of four students are very strongly preferred although smaller groups may also be permitted if and as appropriate – groups and topics must be approved by the course coordinator. Projects will either focus on

- development and testing of a simple software, spreadsheet or Matlab power system modelling and optimisation tool, or
- an in-depth literature survey of some aspect of electricity industry operation and control (3000-5000 words plus tables, diagrams, references etc.).

More information on these projects and suitable topics will be distributed in week 3 and project topics are to be negotiated and finalised by week 6. Details on the formal requirements for the project reports will also be provided at this time. It should contain a significant review of the literature relevant to the topic and a comprehensive bibliography. All source material must be adequately referenced in the body of the report and it is expected that there will be 25 or more scholarly references in a literature survey. It is also required that the project will include some analysis of actual electricity industry operational data.

The group presentations will take place during class time in weeks 12 and 13. Presentations will be a maximum 10 minutes with 5 minutes for questions and should make extensive use of visual aids. A computer and projector for PowerPoint presentations will be available. You will also be able to run the presentation from your own laptop if that is preferred. The presentations must be uploaded onto Moodle where they will be made available to all students in the class. Assessment will be based on the structure, content and clarity of the presentation and how well they answer questions. Note that students will participate in the assessment through a peer review process. More details will be provided during classes closer to the time of the seminar presentations.

For all of the non-exam assessment tasks in this course, it is essential that you have a complete understanding of the UNSW official position on 'In-class assessment and plagiarism' as outlined below. Please note that there are severe penalties associated with plagiarism offences.

## Mid-Semester Exam

The mid-session 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 up to the end of week 6.

## Final Exam

The exam in this course is a standard closed-book 2 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. Questions may be drawn from any aspect of the course unless specifically indicated otherwise by the lecturer.

## Relationship of Assessment Methods to Learning Outcomes

Assessment	Learning outcomes					
	1	2	3	4	5	6
Assignments		✓		✓	✓	
Group project and seminar			✓	✓	✓	✓
Mid-semester exam	✓	✓	✓	✓		
Final exam	✓	✓	✓	✓	✓	✓

## Course Resources

### Textbooks

There is no assigned textbook for this subject. The following book is a useful reference on the traditional, monopoly utility, approach to many of the topics covered in this course, and the third edition also has some useful materials on electricity restructuring:

Allen J Wood and Bruce F Wollenberg, *Power Generation, Operation and Control*, Wiley, 3<sup>rd</sup> Edition, 2014.

The UNSW library has a number of copies at PJ621.31. It is also available online via the UNSW library – search for 'wood wollenberg' to find the online resource. Note that there is a third edition (September 2013) but this is not yet available on-line at the UNSW library.

### On-line resources

More recent concepts relevant to electricity industry operation and control in restructured industries are not easily found in textbooks. Instead, regular updates and course materials will be added to the course Moodle website. You should check this site frequently. Materials will include pdf versions of the lecture PowerPoints (also provided as printouts prior to each lecture). A range of reports, papers and websites will be uploaded throughout the semester to provide more background on electricity industry operation and control within the restructured Australian electricity industry, as well as internationally. Another useful website is that of the UNSW Centre for Energy and Environmental Markets (CEEM) found at [www.ceem.unsw.edu.au](http://www.ceem.unsw.edu.au). It contains useful papers and presentations covering many of the topics that are explored during the course.

As a part of the teaching component, Moodle will be used to disseminate teaching materials, host forums and occasionally quizzes. Assessment marks will also be made available via Moodle: <https://moodle.telt.unsw.edu.au/login/index.php>.

## 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 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.

#### Keeping Informed

Announcements may be made during classes, via email (to your student email address) or via online learning and teaching platforms like Moodle. From time to time, UNSW will send important announcements via these media without providing any paper copy. Please note that you will be deemed to have received this information, so you should take careful note of all announcements.

### 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 details on these arrangements, you can 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.

## 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 Attributes

The course delivery methods and course content addresses a number of core UNSW graduate attributes, as follows:

**UNSW graduates will be -**

***Scholars who are:***

- understanding of their discipline in its interdisciplinary context
- capable of independent and collaborative enquiry
- rigorous in their analysis, critique, and reflection
- able to apply their knowledge and skills to solving problems
- ethical practitioners
- capable of effective communication
- information literate
- digitally literate





**Leaders who are:**

- enterprising, innovative and creative
- capable of initiating as well as embracing change
- collaborative team workers

**Professionals who are:**

- capable of independent, self-directed practice
- capable of lifelong learning
- capable of operating within an agreed Code of Practice

**Global Citizens who are:**

- capable of applying their discipline in local, national and international contexts
- culturally aware and capable of respecting diversity and acting in socially just/responsible ways
- capable of environmental responsibility

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

	<b>Program Intended Learning Outcomes</b>
<b>PE1: Knowledge and Skill Base</b>	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
<b>PE2: Engineering Application Ability</b>	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
<b>PE3: Professional and Personal Attributes</b>	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