ELEC9715

Electricity Industry Operation and Control

Term 1, 2023

Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Iain MacGill	i.macgill@unsw.edu.au	By appointment, or in scheduled course lectures	Tyree Energy Technology Building, Rm 316	via MS Teams

School Contact Information

Consultations: Lecturer consultation times will be advised during the first lecture. You are welcome to email the tutor or laboratory demonstrator, who can answer your questions on this course and can also provide you with consultation times. ALL email enquiries should be made from your student email address with ELEC/TELExxxx 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 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.

Student Support Enquiries

For enrolment and progression enquiries please contact Student Services

Web

Electrical Engineering Homepage

Engineering Student Support Services

Engineering Industrial Training

UNSW Study Abroad and Exchange (for inbound students)

UNSW Future Students

Phone

(+61 2) 9385 8500 – Nucleus Student Hub

(+61 2) 9385 7661 – Engineering Industrial Training

(+61 2) 9385 3179 – UNSW Study Abroad and UNSW Exchange (for inbound students)

Email

Engineering Student Support Services – current student enquiries

- e.g. enrolment, progression, clash requests, course issues or program-related queries

Engineering Industrial Training – Industrial training questions

UNSW Study Abroad – study abroad student enquiries (for inbound students)

UNSW Exchange – student exchange enquiries (for inbound students)

UNSW Future Students – potential student enquiries

- e.g. admissions, fees, programs, credit transfer

Course Details

Units of Credit 6

Summary of the Course

Introduction to the evolving electricity industry drivers of growing environmental concerns, market-oriented restructuring and technological developments, and 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 high levels of renewable generation, flexible resources including strorage and demand management, and distributed energy resources.

Course 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, in place, 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.

Considerable attention is given to practical implementation and experience to date in Australia, with discussion on other countries' electricity industries when appropriate. Students taking this course will therefore gain a critical appreciation of the operation of Australiaâ??s restructured industry.

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. These courses can be taken separately or in either sequence.

Course Learning Outcomes

After successfully completing this course, you should be able to:

Learning Outcome	EA Stage 1 Competencies
1. Understand and explain the fundamental objectives, constraints and concepts of electricity industry operation and control	PE1.1, PE1.3, PE1.6, PE2.2, PE3.1, PE3.2, PE3.4
2. Apply basic conventional economic dispatch, unit commitment, hydro-scheduling, production costing, reliability assessment and operation planning techniques to simple electricity industry problems	PE1.1, PE1.2, PE1.3, PE2.1, PE2.2, PE2.3, PE3.2

Learning Outcome	EA Stage 1 Competencies
3. Describe the implementation of power system operation and control in a restructure industry context including ancillary services, and energy spot and derivative markets	PE1.1, PE1.2, PE1.3, PE1.5
4. Apply basic models for electricity markets to simple and restructured electricity industry problems	PE1.1, PE1.2, PE1.3, PE2.1, PE2.4, PE3.4
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	PE1.1, PE1.2, PE1.3, PE1.4, PE1.6, PE2.2, PE3.1, PE3.2, PE3.3, PE3.4, PE3.6
6. Describe the opportunities and challenges that emerging distributed energy resources pose for future electricity industry operation and control	PE1.2, PE1.3, PE1.4, PE1.5, PE1.6, PE2.4, PE3.6

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.

UNSW Graduate Attributes

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 capable independent and collaborative enquiry, through a series of tutorial exercises

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 technical reports.
- 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.

Teaching Strategies

Lectures will make extensive use of PowerPoint presentations, and white board work. PowerPoint files will be provided at the start of lectures and placed on the course Moodle and MS Teams. Lectures will also be recorded live in MS Teams. Additional information and reading materials will also be progressively made available on this site, but they are no substitute for accurate notes, and active student participation through questions and informal exercises during the lectures. Note that students attending on-line will still be able to participate in these discussions through the MS Teams Chat function.

Students are expected and will benefit from attendance at every lecture, either in-person or on-line. It is possible that some classes will not be held in-person but entirely on-line depending on circumstances over the term. The course will cover a diverse range of material with an approach that is not readily found in text books or the literature. You will also be provided with access to a number of on-line data sources for the Australian National Electricity Market.

Additional Course Information

Pre-requisites: Although this subject has no formal prerequisites, it is assumed that each student has a basic working knowledge of power systems, and the electricity industry more generally. 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). If you are not, then this course will provide an excellent opportunity to improve your skills in using these key productivity tools.

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,* as detailed above. 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 take both of them. *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.

Workload: It is expected that you will spend around **12-15 hours per week** studying a 6 UoC course, from Week 1 until the final assessment, including face-to-face classes where these run, online lectures

and tutorials and *independent, self-directed study*. In periods where you need to need to complete assignments or prepare for examinations, the workload will be greater. Over-commitment is a common challenge for students. You should take the required course workload into account when planning how to balance study with employment and other activities.

Assessment

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Final Exam	40%	Not Applicable	1, 2, 3, 4, 5, 6
2. Student Participation and Quizzes	10%	Not Applicable	1, 2, 3, 4, 5
3. Group Student Project and Group Student Presentation	25%	seminars in week 10, report due week 11	1, 3, 4, 5, 6
4. Individual Student Assignment	25%	submission two weeks after release	1, 2, 3, 4, 5

Assessment 1: Final Exam

Assessment length: 2 hours

The exam in this course will be a 2 hour written examination, comprising four compulsory questions, and marks split equally across short essay style questions testing your knowledge of the materials, and quantitative questions assessing your skills in solving relevant problems. 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. Specific arrangements given the hybrid presentation of the course will be advised when confirmed.

Additional details

	Learning outcomes					
Assessment	**1**	**2**	**3**	**4**	**5**	**6**
Assignments	P	P	P	P	P	
Group project, seminar and wiki	P		P	P	P	P
Class participation	P	P	P	P	P	
Final exam	P	P	P	P	P	P

Assessment 2: Student Participation and Quizzes

Start date: Participation will be assessed over the term

Each student will receive an individual mark according to the quality and extent of their engagement in the lectures and other on-line activities over the term. This will involve the calculation of metrics including how often you attended the lectures, and participated in the various activities and quizzes undertaken during these.

Assessment 3: Group Student Project and Group Student Presentation (Group)

Start date: Work on projects to begin by week 5

Due date: seminars in week 10, report due week 11

The group 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 to five 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. In particular, students undertaking a fourth year engineering thesis or post-graduate research thesis should not choose an ELEC9715 project topic that closely relates to their other thesis research. Similarly, students are strongly encouraged not to choose a project that closely relates to any other projects that they have undertaken – for example, in elec9714 or other electricity industry related courses such as SOLA5053. The intent of these group elec9715 projects is to expose you to electricity industry operation and control issues other than those you might already have already worked on, or are currently working on.

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 (around 5000 words plus tables, diagrams, references etc.).

More information on these projects and suitable topics will be distributed in week 2 and project topics are to be negotiated and finalised by week 4. 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 quantitative analysis of actual electricity industry data. The report will be assessed on the quality of the content and presentation.

Each group is also required to establish a wiki on the course Moodle and use this to communicate their project work and findings with other students taking the course. It is envisaged that you will post an early preliminary outline of progress regarding your topic and host a question forum where other students can come and ask questions or provide comments. Your group will present a project seminar project in week 10 – a short presentation on how your particular topic is relevant to the future of the electricity industry, and then take questions from the audience. If possible this will be a face-to-face activity although online participation will also be possible. **All students are required to attend all of these project seminar sessions and provide a peer mark for each group.**

More details will be provided on the projects and wikis during the lectures, and on Moodle.
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.

Assessment 4: Individual Student Assignment

Start date: Dates to be confirmed but likely week 3 and then week 6
Due date: submission two weeks after release

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 report. These assignments must be undertaken by students individually. It is expected that there will be two such assignments during the

term. Provisional dates for assignment distribution and submission are provided in the course syllabus.

This assignment is submitted through Turnitin and students can see Turnitin similarity reports.

Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

Course Schedule

Indicative Lecture Schedule (subject to change)

WK	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. Key technologies for generation, networks, loads and their control capabilities	Student surveys and quiz tasks.
2	Generation technology operational characteristics Decision making tools Economic dispatch (utilisation of operating generators & loads)	Quiz tasks [out] Information on group projects and possible topics
3	Continuous voltage and frequency control Contingencies and their management	Quiz tasks [out] Assignment 1
4	Unit commitment (selection of generators & loads to operate)	Quiz tasks Group project topics finalized by end week 4
5	Energy constraints: hydro, fuel management and maintenance scheduling	Quiz tasks [in] Assignment 1
6	Flexibility week	Consultations and revision [out] Assignment 2
7	Practical electricity industry arrangements for operation and control	Quiz tasks Project group discussions with course coordinator
8	Operation and control issues associated with variable and only partially controllable generation	Quiz tasks [in] Assignment 2
9	The operational challenges of distributed energy resources Electricity industry operation in a ‘smart grid’ low carbon future	[out] Exam prep. guidance and sample questions
10	Student group project presentations	Presentation to be loaded into Moodle one hour prior to class
11	Optional course review and exam guidance session	Project group wikis finalized and reports due week 11

Resources

Recommended 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, Bruce F Wollenberg and Gerard Sheble, *Power Generation, Operation and Control*, Wiley, 3rd Edition, 2014.

The UNSW library has this book available as an e-book.

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. Materials will include pdf versions of the lecture PowerPoints (also provided prior to each lecture). A range of reports, papers and websites will be uploaded throughout the term 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 Collaboration on Energy and Environmental Markets (CEEM) found at 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 weekly quizzes. Assessment marks will also be made available via Moodle: https://moodle.telt.unsw.edu.au/login/index.php.

Course Evaluation and Development

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.

Laboratory Workshop Information

No labs in this course

Academic Honesty and Plagiarism

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.

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.

Academic Information

COVID19 - 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. **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.

Dates to note

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

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 formal 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.

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.

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.unsw.edu.au/engineering/our-schools/electrical-engineering-telecommunications/student-life/resources

Disclaimer

This Course Outline sets out description of classes at the date the Course Outline is published. The nature of classes may change during the Term after the Course Outline is published. Moodle should be consulted for the up-to-date class descriptions. If there is any inconsistency in the description of activities between the University timetable and the Course Outline (as updated in Moodle), the description in the Course Outline/Moodle applies.

Image Credit

Synergies in Sound 2016

CRICOS

CRICOS Provider Code: 00098G

Acknowledgement of Country

We acknowledge the Bedegal people who are the traditional custodians of the lands on which UNSW Kensington campus is located.

Appendix: Engineers Australia (EA) Professional Engineer Competency Standard

Program Intended Learning Outcomes	
Knowledge and skill base	
PE1.1 Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline	✓
PE1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline	✓
PE1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline	✓
PE1.4 Discernment of knowledge development and research directions within the engineering discipline	✓
PE1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline	✓
PE1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline	✓
Engineering application ability	
PE2.1 Application of established engineering methods to complex engineering 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	✓
Professional and personal attributes	
PE3.1 Ethical conduct and professional accountability	✓
PE3.2 Effective oral and written communication in 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	✓