



School of Electrical Engineering and Telecommunications  
Term 3, 2022  
Course Outline  
**GSOE9141- Smart Grids**

## Course Staff

Course Convener & Lecturer: Dr. Georgios Konstantinou  
Senior Lecturer  
School of Electrical Engineering and Telecommunications  
Room 325, Tyree Energy Technologies Building (H6)  
e-mail: [g.konstantinou@unsw.edu.au](mailto:g.konstantinou@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. You can also post questions in the Moodle discussion forums and in Microsoft Teams course pages. ALL email enquiries should be made from your student email address with GSOE9141 in the subject line, otherwise they will not be answered.

Consultation times for the course will be confirmed during Weeks 1 and 2, aiming to provide a flexible experience for all students, regardless of location and timezone. Consultations will be scheduled via Microsoft Teams.

**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 enrollment 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)

## 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. 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

Units of Credit 6

## Course Rationale

Implementation of Smart Grid strategies by power utilities necessitates a new set of skills, experiences and knowledge. Understanding the Smart Grid requires knowledge of numerous key engineering topics in electrical and power engineering, telecommunications and information technologies. Such key engineering disciplines also must intersect other disciplines including sciences, markets, business strategies and processes, energy related policies and regulation. The Smart Grid requires a suite of new standards to be developed and implemented from the technical point of view. Moreover, the Smart Grid is a customer-centred transformation of aged electricity grids and promises to deliver many benefits to customers, hence consumer behaviour and social sciences also play an important role in smart grids.

Professionals and engineers working in the power industry and information and communications technologies will seek to upgrade and expand their practical skills to meet unprecedented market demand. This course provides a cross-disciplinary overview approach of the various topics of a Smart Grid ranging from the fundamentals of Smart Grids to renewable energy systems, energy storage, IT communications and standards. The course focuses mainly on intelligent electricity distribution networks and provides the basis for the new thinking and design methodology required by engineers and professionals for transforming the current distribution networks to become a major part of the future intelligent electricity network.

## Handbook Description

A Smart Grid is the integration of numerous technologies, systems and processes with the aim to modernise and fully automate the entire electricity grid covering generation, transmission, distribution, utilisation plus conservation of energy. Smart grids will revolutionise the design, development, management, operation and maintenance of the grid to levels that were thought impossible some decades ago. The driving force behind Smart Grids include environmental awareness of people and governments; the need for further automation and energy efficiency; large capital investments for the renewal of the ageing infrastructure in most developed countries including Australia; adoption of competitive energy prices; security of supply; energy conservation and the ever increasing electricity demand that needs to be met. The course will provide advanced information and thinking required by engineers and professionals to deliver Smart Grid concepts from inception to implementation. The course will mainly focus on intelligent electricity distribution networks, present the latest technologies used to automate such networks and analyse the impact of these technologies on system design, operation, management and maintenance.

## Context and Aims

The aims of the course are to:

- Present the fundamental concepts associated with Smart Grids.
- Review renewable energy generation, grid integration energy storage technologies and future developments
- Introduce advanced management and control concepts of Smart Grids.
- Construct the data management requirements and ICT technologies for Smart Grids.
- Present standards related to the development of smart grids, identify key stakeholders and potential impact.

## Contact Hours

The course consists of:

1. One 2-3 hours session of flexible teaching time each week that will be used for lectures, workshops, presentations etc

## Indicative Lecture Schedule

| Period              | Summary of Lecture Program <sup>1</sup>  |
|---------------------|--|
| Week 1              | Introduction to Smart Grids and Intelligent Distribution Networks                                      |
| Week 2              | Renewable Energy Integration in Smart Grids & Energy Storage Technologies                              |
| Week 3              | Demand Side Management, Demand Response and Demand Pricing   |
| Week 4              | FDIR and Volt-var Optimisation - Asset Health Management   |
| Week 5              | Smart Meters - Electric Vehicles in Smart Grids  |
| Week 6              | IT Networks and Security & Telecommunication Systems in Smart Grids                                    |
| Week 7              | Smart Grid Standards   |
| Week 8              | Economics of Smart Grids & Impact, Policies, Demonstration Projects, Stakeholders and the way forward. |
| Week 9 &<br>Week 10 | Project Presentations  |

## Assessment

### Pre-requisites to pass the course

Normal assessment for this course is not affected by online delivery for T2, 2021 and will remain similar to previous year.

In order to receive a passing mark for the course, submission and participation in all summative assessment and an overall passing mark of **50/100** is required.

|                                       |               |
|---------------------------------------|---------------|
| Assessment Task 1 (Biweekly Reports)  | 30% (3 x 10%) |
| Assessment Task 2 (MCQ)               | 15%           |
| Assessment Task 3 (Literature Review) | 30%           |
| Assessment Task 4 (Modeling)          | 25 %          |

---

<sup>1</sup>Lecture Schedule may change to meet requirements of the term and online course delivery requirements.

## Course Details

### Credits

This is a 6 UoC course and the expected workload is **8 - 10 hours** per week throughout the 10 week Term.

### Relationship to Other Courses

This is a postgraduate course in the School of Electrical Engineering and Telecommunications offered through the Graduate School of Engineering.

### Pre-requisites and Assumed Knowledge

There are no pre-requisites courses for attending GSOE9141.

### Learning outcomes

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

1. LO1: Identify the key elements of Smart Grids and visualise the roadmap towards next-Gen electricity networks.
2. LO2: Evaluate technology options pertaining to renewable energy generation, energy storage, data handling and communications for Smart Grids.
3. LO3: Justify technological and economical choices in the context of existing commercial Smart Grids projects and suggest improvements and expansions.
4. LO4: Determine the relevance of Smart Grids projects, develop ways to evaluate their impacts and implications
5. LO5: Analyse the new roles of utilities and consumers in Smart Grids and pinpoint business and market opportunities and potential gains.

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

Smart grids; Intelligent Distribution Networks; Renewable Energy; Distributed Generation; DG Integration; Solar; Wind; Energy Storage Technologies; Chemical, Mechanical and Electrical Energy Storage; Demand Side Management; Load Management; Demand Side Response; Conservation Voltage Reduction; Demand Pricing; Time of Use; Real Time Pricing; Peak Time Pricing; FDIR; Reactive Power Optimisation; Volt-Var Optimisation; Distribution Automation; Advanced Asset Management; Electric Vehicles; Smart Meters; Advanced Measuring Infrastructure; Distribution Management Systems; Smart Grid ICT; Common Information Model; Cyber-Security; Wide Area Measurement Systems; Smart Grid Communications; SCADA; SG costs; Markets; Ancillary Markets; Smart Grid Standards; Substation Automation; Stakeholders and Benefits;

# Teaching Strategies

## Delivery Mode

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

- Weekly Seminars
- Course material provided through Moodle
- Supplementary video resources
- Relevant Assessment Tasks

You are expected to attend all lectures of the course. The facilitator will discuss assessment and assignment criteria and comment on current assessment tasks and marks during these six sessions.

The material of the course will be provided on-line through UNSW's Moodle page. The students are expected to follow the material of the course as it is weekly updated on the website but they are free to study on their own pace.

Additional video resources will be also linked. These resources have been selected as they provide valuable insights from industrial meetings and forums, enhance the coverage of the material and should be considered as content of the course. You can view these resources at your own pace, and you will be required to comment and express your opinions and ideas during lectures.

The rationale behind these methods of delivery for the course is that the Smart Grid is a complex collection of different technologies and the course offers a “bird’s eye” view of the core components. The course is not designed to be a power system analysis or telecommunication course but provides the students with the knowledge and the resources in order to identify and tackle the requirements in the current transformation of the electricity networks.

## Learning in this Course

Well done for reading so far in this course outline. The first two students to e-mail me and mention this section of the course, will get two and one bonus marks in their final course mark. You are expected to attend all lectures, tutorials, labs, and mid-term exams in order to maximise learning. You must prepare well for your laboratory classes and your lab work will be assessed. 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.

## Assessment

The assessment scheme in this course reflects the intention to assess your learning progress through the term. Ongoing assessment occurs through bi-weekly learning journal submissions and early assessment submission requirements.

### Final Exam

The course does not have a final exam.

### Assignments

The course does not include a final exam and all assessment (formative and summative) will take place throughout the term. The assessment tasks include:

- **ASMT1:** 3 reports which include brief literature reviews or research related to the topics discussed in the course. Bi-weekly reports (learning Journals) (3 x 10 marks = 30 marks)
- **ASMT2:** Multiple choice test (1 x 15 marks = 15 marks)
- **ASMT3:** A literature review of a topic of your choice relevant to Smart Grids. A list of suggested topics will be made available in Week 2 (Presentation 10 marks - Final Report 20 marks).
- **ASMT4:** A comprehensive report on the economic assessment and impact of the Smart Grid-Smart City project based on the modeling available by AusGrid. (25 marks)

### Submission of Assessment Tasks

Assessment tasks will be submitted via the Moodle page of the course. Each assessment task will have two deadlines, a soft deadline for the submission of each assignment after which submissions will incur a 10% penalty per day of delayed submission. The soft deadline will be followed by a hard deadline three days later, after which no marks will be given to an assignment. Submission of an assignment past the hard deadline will be accepted via email.

Marking of the assessments will be based on a detailed rubric that will be made available in Moodle during the first week of the term and explained in detail at the first face-to-face session of the course.

### Relationship of Assessment Methods to Learning Outcomes

|            | Learning Outcomes |   |   |   |   |
|------------|-------------------|---|---|---|---|
| Assessment | 1                 | 2 | 3 | 4 | 5 |
| ASMT 1     | ✓                 | ✓ | ✓ | ✓ | ✓ |
| ASMT 2     | ✓                 | ✓ |   |   |   |
| ASMT 3     | ✓                 | ✓ | ✓ | ✓ | ✓ |
| ASMT 4     | ✓                 | ✓ | ✓ | ✓ | ✓ |

# Course Resources

## Textbooks

### Prescribed textbook

No textbook is prescribed for the course and the presentations – notes include material from a wide range of sources that cover the different aspects of the Smart Grid. References to related books and supplementary reading and video material) will be provided when deemed necessary.

However, since T2, 2021 we have started using additional resources based on Chapters of the following textbook:

Bernd M. Buchholz & Zbigniew A. Styczynski " Smart Grids Fundamentals and Technologies in Electric Power Systems of the future" Springer-Verlag GmbH Germany, part of Springer Nature 2020

which is available through the UNSW library and will also be shared through Moodle. Additional major references of the subject include the

- IEEE Transactions on Smart Grid
- IEEE Innovative Smart Grid Technologies Conference (ISGT) family of conferences

### Additional References

Links to supplementary resources and material will be given each week at the course's Moodle website. Some references related to the subject are the following:

- CW Gellings, "The Smart Grid, Enabling Energy Efficiency and Demand Side Response"- CRC Press, 2009.
- J Ekanayake, K. Liyanage, J.Wu, A. Yokoyama, N. Jenkins, "Smart Grid: Technology and Applications"- Wiley, 2012.
- James Momoh, "Smart Grid: Fundamentals of Design and Analysis"- Wiley, IEEE Press, 2012.
- The Smart Grid: Adapting the Power System to New Challenges, Bollen, Math H J, Morgan & Morgan Publishers, 2011
- The Smart Grid: An Introduction, Department of Energy (US)
- Towards Smart Power Networks – Lessons learned from European Research Framework Program 5 Projects, European Union
- S.E. Collier, Ten Steps to a Smarter Grid, IEEE Industry Applications Magazine, Volume: 16, Issue: 2, 2010, pp. 62-68
- V.C. Gungor, D. Sahin, T. Kocak, S. Ergut, C. Buccella, C. Cecati, G.P. Hancke, G.P.; "Smart Grid Technologies: Communication Technologies and Standards", IEEE Transactions on Industrial Informatics, Vol. 7, No 4, 2011 , pp. 529-539
- G.W. Arnold, "Challenges and Opportunities in Smart Grid: A Position Article", Proceedings of the IEEE, Volume: 99 , Issue: 6, 2011, pp. 922-927
- N. Hatziaargyriou, H. Asano, R. Iravani, C. Marnay, "Microgrids", IEEE Power and Energy Magazine, Vol.: 5 , No: 4, 2007, pp. 78-94
- F. Bouhafs, M. Mackay, M. Merabti, "Links to the Future: Communication Requirements and Challenges in the Smart Grid", IEEE Power and Energy Magazine, Volume: 10 , Issue: 1, 2012, pp. 24-32
- Koutsopoulos, L. Tassioulas, "Challenges in demand load control for the smart grid", IEEE Network, Vol.: 25 , Issue: 5, 2011, pp. 16-21

## On-line resources

### Moodle

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>.



# 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.

## Student Responsibilities and Conduct

Students are expected to be familiar with and adhere to all [UNSW policies](#), and particular attention is drawn to the following:

### Workload

It is expected that you will spend at least 16 to 18 hours per week studying a 6 UoC course over the term, 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.

### 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, enrollment, rights, and general expectations of students, please refer to the School and UNSW policies:

[Policies and Procedures](#)

<https://student.unsw.edu.au/guide>

## **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. Test, one, two. Does anybody actually read this text or do I put all this effort for nothing? Probably it is for nothing, yet here I am on a Saturday morning typing this instead of catching up with the CSGO major games from last night. Anyways the first three that make it all the way here and e-mail me a photo of Lab as you exit the lifts on level 3 of the TETB will get a bonus mark for the course. I mean, nothing beats free. If you not in Australia you can still do this, e-mail a photo of your workstation that you will be studying this course. Anyways, what was I talking about? Yup, course improvement. 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.

## **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.

No animals were hurt during the production of this course outline.

## **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.

# 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 <select those which apply (maybe 3-5) and adapt to suit course>:

- 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

|  | <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   |   |