UNSW Course Outline

ELEC2911 Power Engineering for Renewable Energy - 2024

Published on the 25 Aug 2024

General Course Information

Course Code : ELEC2911
Year : 2024
Term : Term 3
Teaching Period : T3
Is a multi-term course? : No
Faculty : Faculty of Engineering
Academic Unit : School of Electrical Engineering & Telecommunications
Delivery Mode : In Person
Delivery Format : Standard
Delivery Location : Kensington
Campus : Sydney
Study Level : Postgraduate, Undergraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

Renewable Energy has become a real alternative to electricity generation based on fossil fuels due to their superior sustainability credentials and the low cost achieved during the last decade, thanks to heavy investment in research, development, and large-scale manufacturing. As such,

renewable energy systems like solar and wind are expected to become the leading generation sources in the next few decades and provide most of the energy needs for our society. These renewable energy systems must be integrated into the electrical network so the energy can be used safely and efficiently where and when it is needed most.

This course will teach the principles of power engineering, emphasizing renewable energy systems, including single and 3-phase AC circuit calculations, principles of transformers and power electronic converters, principles of solar and wind energy conversion systems, and an introduction to AC transmission and distribution infrastructure.

Course Aims

The course aims to:

- Reinforce students' understanding of core power engineering principles while also building their capabilities in the practice of core power engineering.
- Improve students' ability to analyse and evaluate the operation and integration of renewable energy systems, leading to a better comprehension of their current and future impact.
- Develop professional skills and help students become familiar with techniques used in power engineering systems through workshops and laboratory work.

Relationship to Other Courses

The pre-requisite for this course is ELEC1111, Electrical Circuit Fundamentals. You are strongly advised to revise the circuit analysis techniques in ELEC1111 in your own time to get yourself ready for this course.

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Explain the basic operation of single-phase and three-phase AC systems
CLO2 : Calculate real and reactive power and power factor in single-phase and three-phase systems
CLO3 : Explain the basic operation of transformers
CLO4 : Describe the operation of power electronic converters, their interface to electrical networks, and perform basic calculations
CLO5 : Describe the characteristics and applications of electromechanical machines in renewable energy systems and perform basic calculations
CLO6 : Explain the principles of operation of photovoltaic and wind energy conversion systems
CLO7 : Describe the relationship between demand and generation, and voltage and reactive power

Course Learning Outcomes	Assessment Item
CLO1 : Explain the basic operation of single-phase and three-phase AC systems	• AC theory laboratories • Final Exam • Mid-Term Exam
CLO2 : Calculate real and reactive power and power factor in single-phase and three-phase systems	• AC theory laboratories • Final Exam • Mid-Term Exam
CLO3 : Explain the basic operation of transformers	• AC theory laboratories • Final Exam • Mid-Term Exam
CLO4 : Describe the operation of power electronic converters, their interface to electrical networks, and perform basic calculations	• Power electronic laboratories • Final Exam • Mid-Term Exam
CLO5 : Describe the characteristics and applications of electromechanical machines in renewable energy systems and perform basic calculations	• Final Exam
CLO6 : Explain the principles of operation of photovoltaic and wind energy conversion systems	• Final Exam
CLO7 : Describe the relationship between demand and generation, and voltage and reactive power	• Final Exam

Learning and Teaching Technologies

Moodle - Learning Management System | Microsoft Teams

Learning and Teaching in this course

Lecture classes

The lectures form the core of this subject. Topics presented in lectures will generally be followed by detailed examples to provide students with real-life applications. Detailed explanations of the topics will be available to students in the form of lecture slides and lecture videos, which will be uploaded on Moodle.

Workshop classes

The tutorial problems provide students with an in-depth quantitative understanding of the topics covered in lectures. The problems will be posted on Moodle prior to the tutorial classes. Students are encouraged to attempt them before coming to the tutorial. A discussion forum for the tutorial problems will be made available on Moodle for students to post their solutions and discuss

them. During the tutorial session, solutions for the problems will be covered focusing on the challenges and issues raised by students in the discussion forum. Since there will not be enough time to cover all problems during the tutorial class, the tutorial will focus on selected problems and high-level discussion.

Laboratory program

The laboratory schedule is deliberately designed to provide exposure to the concepts conveyed in lectures. The laboratories are done by students on their own computers in Weeks 7 to 10 at their own pace. It is anticipated that each lab will take 3 hours to complete. There will be three laboratory experiments in the course, each of which will consist of several parts. One week is reserved for students to install and get familiar with the simulation software LTspice. A lab demonstrator will be present during the scheduled lab times.

Laboratory Exemption

There is no laboratory exemption for this course. Regardless of whether equivalent labs have been completed in other courses, all students enrolled in this course must take the labs.

Other Professional Outcomes

Relationship to Engineers Australia Stage 1 competencies:

The Course Learning Outcomes (CLOs) contribute to the Engineers Australia (National Accreditation Body) Stage I competencies as outlined below

Engineers Australia (EA), Professional Engineer Stage 1 Competencies

PE1: Knowledge and Skill Base:
PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals: CLO 1, 2, 3, 4, 5, 6, 7
PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing: CLO 1, 2, 3, 4, 5
PE1.3 In-depth understanding of specialist bodies of knowledge: CLO 1, 2, 3, 4, 5, 6, 7
PE1.4 Discernment of knowledge development and research directions: n/a
PE1.5 Knowledge of engineering design practice: n/a
PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice: n/a

PE2: Engineering Application Ability:

PE2.1 Application of established engineering methods to complex problem solving: CLO 1, 2, 3, 4, 5, 6, 7

PE2.2 Fluent application of engineering techniques, tools and resources: CLO 1, 2, 3, 4, 5, 6, 7

PE2.3 Application of systematic engineering synthesis and design processes: n/a

PE2.4 Application of systematic approaches to the conduct and management of engineering projects: n/a

PE3: Professional and Personal Attributes:

PE3.1 Ethical conduct and professional accountability: n/a

PE3.2 Effective oral and written communication (professional and lay domains): CLO 1, 2, 3, 4, 5, 6, 7

PE3.3 Creative, innovative and pro-active demeanour: n/a

PE3.4 Professional use and management of information: CLO 1, 2, 3, 4, 5, 6, 7

PE3.5 Orderly management of self, and professional conduct: n/a

PE3.6 Effective team membership and team leadership: n/a

This course is also designed to provide the course learning outcomes which arise from targeted graduate capabilities. The targeted graduate capabilities broadly support the UNSW and Faculty of Engineering graduate capabilities (also listed below).

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 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 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 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.

Additional Course Information

The course consists of a total of 4 hrs of lectures weekly, a 1-hr of tutorial (every two weeks), and a 3-hrs laboratory (weeks 7-10). Lectures will begin in week 1. Workshops will start in week 2. Laboratory sessions will start in week 7.

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Power electronic laboratories Assessment Format: Individual	20%	Start Date: Week 9 Due Date: Week 10
AC theory laboratories Assessment Format: Individual	10%	Start Date: Week 7 Due Date: Week 8
Final Exam Assessment Format: Individual	50%	Start Date: TBA Due Date: TBA
Mid-Term Exam Assessment Format: Individual	20%	Start Date: Week 7 Due Date: Not Applicable

Assessment Details

Power electronic laboratories

Assessment Overview

You will be required to write up in your laboratory book a detailed account of your experiments. You will have to submit a report with answers to the given questions. Marks will be assigned according to the correctness of the responses. The lab demonstrator will provide feedback on the responses upon request.

Course Learning Outcomes

- CLO4 : Describe the operation of power electronic converters, their interface to electrical networks, and perform basic calculations

Assignment submission Turnitin type

Not Applicable

Generative AI Permission Level

No Assistance

This assessment is designed for you to complete without the use of any generative AI. You are not permitted to use any generative AI tools, software or service to search for or generate information or answers.
For more information on Generative AI and permitted use please see here.

AC theory laboratories

Assessment Overview

You will be required to write up in your laboratory book a detailed account of your experiments. You will have to submit a report where you compare the results from your analytical solutions and the simulation and answer the given questions. Marks will be assigned according to the correctness of the responses. The lab demonstrator will provide feedback on the responses upon request.

Course Learning Outcomes

- CLO1 : Explain the basic operation of single-phase and three-phase AC systems
- CLO2 : Calculate real and reactive power and power factor in single-phase and three-phase systems
- CLO3 : Explain the basic operation of transformers

Assignment submission Turnitin type

Not Applicable

Generative AI Permission Level

No Assistance

This assessment is designed for you to complete without the use of any generative AI. You are not permitted to use any generative AI tools, software or service to search for or generate information or answers.
For more information on Generative AI and permitted use please see here.

Final Exam

Assessment Overview

The final examination tests analytical and critical thinking and a general understanding of the course material. Questions may be drawn from any aspect of the course that has been presented in lectures, workshops and/or laboratories, unless specifically indicated otherwise by the lecturer. Marks will be assigned according to the correctness of the responses.

Course Learning Outcomes

- CLO1 : Explain the basic operation of single-phase and three-phase AC systems
- CLO2 : Calculate real and reactive power and power factor in single-phase and three-phase systems
- CLO3 : Explain the basic operation of transformers
- CLO4 : Describe the operation of power electronic converters, their interface to electrical networks, and perform basic calculations
- CLO5 : Describe the characteristics and applications of electromechanical machines in renewable energy systems and perform basic calculations
- CLO6 : Explain the principles of operation of photovoltaic and wind energy conversion systems
- CLO7 : Describe the relationship between demand and generation, and voltage and reactive power

Assignment submission Turnitin type

Not Applicable

Generative AI Permission Level

No Assistance

This assessment is designed for you to complete without the use of any generative AI. You are not permitted to use any generative AI tools, software or service to search for or generate

information or answers.
For more information on Generative AI and permitted use please see here.

Mid-Term Exam

Assessment Overview

The mid-term examination tests your general understanding of the course material up to week 4, unless specifically indicated otherwise by the lecturer. It is designed to give you feedback on your progress through the analytical components of the course. Questions may be drawn from any material already covered in the course schedule. Marks will be assigned according to the correctness of the responses. Feedback will be provided via an exam review session and the exam will be solved and discussed in detail.

Course Learning Outcomes

- CLO1 : Explain the basic operation of single-phase and three-phase AC systems
- CLO2 : Calculate real and reactive power and power factor in single-phase and three-phase systems
- CLO3 : Explain the basic operation of transformers
- CLO4 : Describe the operation of power electronic converters, their interface to electrical networks, and perform basic calculations

Assessment Length

TBA

Assessment information

Mid-term exam special consideration results in the final exam weightage going from 50 to 70%.

Assignment submission Turnitin type

Not Applicable

Generative AI Permission Level

No Assistance

This assessment is designed for you to complete without the use of any generative AI. You are not permitted to use any generative AI tools, software or service to search for or generate information or answers.
For more information on Generative AI and permitted use please see here.

General Assessment Information

Grading Basis

Standard

Requirements to pass course

Achieve a composite mark of at least 50 out of 100.

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 9 September - 15 September	Lecture	AC circuit calculations – voltage, current, phasors, impedance, sources, loads, RLC passives
Week 2 : 16 September - 22 September	Lecture	Single-phase power– real and reactive power, power factor. Transformers
	Workshop	Single-phase AC circuits (Tutorial 1)
Week 3 : 23 September - 29 September	Lecture	Three-phase circuits – phase & line quantities, power in balanced 3-phase systems.
Week 4 : 30 September - 6 October	Lecture	PV energy conversion systems. Principles of power electronic converters.
	Workshop	Three-phase AC circuits and transformers (Tutorial 2)
Week 5 : 7 October - 13 October	Lecture	Single and three-phase power electronic converters.
Week 6 : 14 October - 20 October	Blended	Flexibility week.
Week 7 : 21 October - 27 October	Lecture	Principles of energy conversion, wind energy conversion systems. EMF and torque calculations.
	Assessment	Mid-term exam
	Laboratory	Introduction of LTspice (Lab 1)
Week 8 : 28 October - 3 November	Lecture	AC machines.
	Workshop	Power electronic converters and PV systems (Tutorial 3)
	Laboratory	AC calculations (Lab 1)
Week 9 : 4 November - 10 November	Lecture	Structure of power systems. Introduction to AC transmission and distribution infrastructure.
	Laboratory	DC-DC Step-Down (Buck) Converter (Lab 2)
Week 10 : 11 November - 17 November	Lecture	Relationship between demand and generation (frequency and load control). Relationship between voltage and reactive power.
	Workshop	Electromechanical machines, transmission, and distribution (Tutorial 4)
	Laboratory	DC-DC Step-up (Boost) Converter (Lab 3)

Attendance Requirements

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

Course Resources

Prescribed Resources

Moodle

The course web page is hosted on the UNSW's Moodle server, which can be accessed at: https://

moodle.telt.unsw.edu.au/login/index.php. All lectures, workshops, labs, video and any other resources will be available on this page, as well as access to the student marks, discussion forums and official course announcements. It is a requirement of the course that students check this page for new announcements on a daily basis.

Recommended Resources

Recommended books:

- C. K. Alexander and M. N. O. Sadiku, Fundamentals of Electric Circuits, 6th ed., New York, NY, USA: McGraw-Hill, 2017.
- Ned Mohan, Tore M. Undeland, William P. Robbins, 'Power Electronics: Converters, Applications, and De-sign', Wiley, 3rd Edition, 2002.
- Turan Goì^nen, 'Electric Power Distribution Engineering', 3rd Edition, CRC Press, 2014.
- William H. Kersting, 'Distribution System Modelling and Analysis', 4th Edition, CRC Press, 2017.
- Electric Drives by Ion Boldea and S. A. Nasar, CRC Press, 3rd edition, 2017.

Course Evaluation and Development

This course is under constant revision in order to improve the learning outcomes for all students. Please forward any feedback on the course to the course convener or via the Course and Teaching Evaluation and Improvement Process.

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Branislav Hrdzak		TETB, 324	93854895	See Moodle	No	Yes
Demonstrator	Arman Ali					No	No
	Shyamal Chand					No	No

Other Useful Information

Academic Information

I. Special consideration and supplementary assessment

If you have experienced an illness or misadventure beyond your control that will interfere with your assessment performance, you are eligible to apply for Special Consideration prior to, or within 3 working days of, submitting an assessment or sitting an exam.

Please note that UNSW has a Fit to Sit rule, which means that if you sit an exam, you are declaring yourself fit enough to do so and cannot later apply for Special Consideration.

For details of applying for Special Consideration and conditions for the award of supplementary assessment, please see the information on UNSW's Special Consideration page.

II. Administrative matters and links

All students are expected to read and be familiar with UNSW guidelines and polices. In particular, students should be familiar with the following:

- Attendance
- UNSW Email Address
- Special Consideration
- Exams
- Approved Calculators
- Academic Honesty and Plagiarism
- Equitable Learning Services

III. Equity and diversity

Those students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course convener prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equitable Learning Services. Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.

IV. Professional Outcomes and Program Design

Students are able to review the relevant professional outcomes and program designs for their streams by going to the following link: https://www.unsw.edu.au/engineering/student-life/student-resources/program-design.

Note: This course outline sets out the 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 or your primary learning management system (LMS) 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/Moodle/LMS, the description in the Course Outline/Moodle/LMS applies.

Academic Honesty and Plagarism

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW students have a responsibility to adhere to this principle of academic integrity. Plagiarism undermines academic integrity and is not tolerated at UNSW. *Plagiarism at UNSW is defined as using the words or ideas of others and passing them off as your own.*

Plagiarism is a type of intellectual theft. It can take many forms, from deliberate cheating to accidentally copying from a source without acknowledgement. UNSW has produced a website with a wealth of resources to support students to understand and avoid plagiarism, visit: student.unsw.edu.au/plagiarism. The Learning Centre assists students with understanding academic integrity and how not to plagiarise. They also hold workshops and can help students one-on-one.

You are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting and the proper referencing of sources in preparing all assessment tasks.

Repeated plagiarism (even in first year), plagiarism after first year, or serious instances, may also be investigated under the Student Misconduct Procedures. The penalties under the procedures can include a reduction in marks, failing a course or for the most serious matters (like plagiarism in an honours thesis or contract cheating) even suspension from the university. The Student Misconduct Procedures are available here:

www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf

Submission of Assessment Tasks

Work submitted late without an approved extension by the course coordinator or delegated authority is subject to a late penalty of five percent (5%) of the maximum mark possible for that assessment item, per calendar day.

The late penalty is applied per calendar day (including weekends and public holidays) that the assessment is overdue. There is no pro-rata of the late penalty for submissions made part way through a day. This is for all assessments where a penalty applies.

Work submitted after five days (120 hours) will not be accepted and a mark of zero will be

awarded for that assessment item.

For some assessment items, a late penalty may not be appropriate. These will be clearly indicated in the course outline, and such assessments will receive a mark of zero if not completed by the specified date. Examples include:

- Weekly online tests or laboratory work worth a small proportion of the subject mark;
- Exams, peer feedback and team evaluation surveys;
- Online quizzes where answers are released to students on completion;
- Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date; and,
- Pass/Fail assessment tasks.

Faculty-specific Information

Engineering Student Support Services – The Nucleus - enrolment, progression checks, 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

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)

School-specific Information

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.

Use of AI for assessments

Your work must be your own. If you use AI in the writing of your assessment, you must acknowledge this and your submission must be substantially your own work. More information can be found on this website.

Workplace Health & Safety (WHS)

WHS for students and staff is of utmost priority. Most courses involve laboratory work. You must follow the rules about conduct in the laboratory. About COVID-19, advice can be found on this website.

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