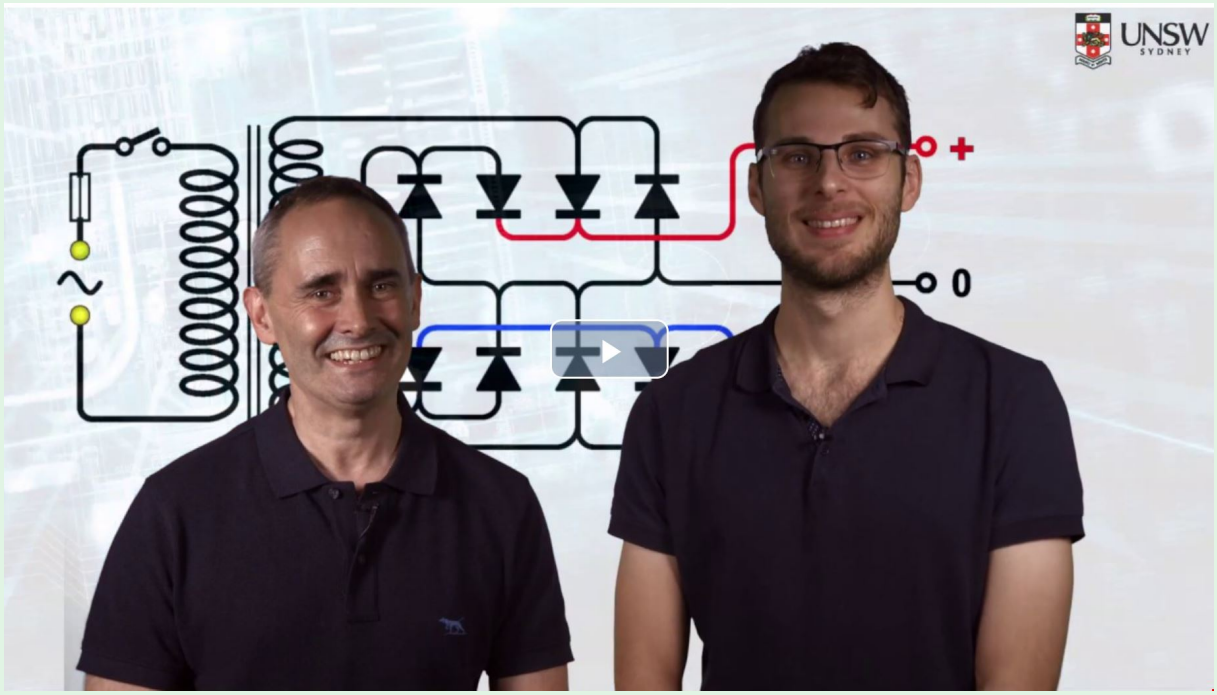
ELEC9711

Power Electronics for Renewable and Distributed Generation

Term 3, 2021



Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
John Fletcher	john.fletcher@unsw.edu.au		Building G17, Room 404	0293856007

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

The topics to be covered in this course will include: Grid integration of electrical power from renewable sources; Current and voltage control; Advanced topics in DC-DC converters, inverters, AC-DC converters and AC-AC converters for use in utility interfacing; resonant converters for DC-DC conversion; dynamic representation of DC-DC converters, control loops design; converter circuit and system modelling using LTSpice or other platforms, device selection and their modeling, thermal design, gate drive circuit design, magnetic core and other component selection and design, and case studies of converter system designs.

Course Aims

The aim of this course is to equip students with more in-depth knowledge of power converter circuits than is possible in an introductory course. Converters with non-ideal devices and components and their control characteristics (both steady-state and dynamic) as encountered in real converters are treated. Converters systems of much greater complexity and application requirements are covered. Modelling of converter circuits and systems on PSIM and Matlab/Simulink and other platforms are introduced, with a view to acquaint students with such design platforms.

Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. Understand and explain the use of power converters in wind turbines and PV applications	PE1.1, PE1.2, PE1.3, PE1.6
2. Understand and explain the concept of maximum power point tracking	PE1.1, PE2.1
3. Understand and explain how real and reactive power flow can be controlled from a renewable or distributed energy resource to the utility network	PE1.1, PE2.1
4. Understand and explain the basic components of an HVDC system and the control of real power flow	PE1.1
5. Understand and explain power converters with non-ideal devices and elements	PE1.1, PE1.2, PE2.1
6. Develop analytical techniques for analysing the steady-state and dynamic characteristics of converters	PE1.1
7. Understand and explain the quadrant operation of various types of converters and their control requirements, selection of	PE1.1, PE1.2

Learning Outcome	EA Stage 1 Competencies
converters, components, etc	
8. Understand and explain how to design the hierarchical control structures for power converters and systems	PE1.1, PE1.5, PE2.1
9. Be able to select and design important elements of a power converter system	PE1.1, PE1.3, PE1.5, PE2.1, PE2.3, PE3.3, PE3.4
10. Be able to apply the theories of power electronic converters and control system design to implement power converter systems which are appropriate for specific applications	PE1.1, PE1.3, PE1.5, PE2.1, PE2.3

Teaching Strategies

Teaching consists of face-to-face lectures which explain the concepts, while problem solving sessions will supplement the lectures to reinforce the concepts?? [Please edit - does not have to be grand]

Additional Course Information

Delivery Mode

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

- Online lecture videos and screencasts which explain the important concepts for each topic of the course;
- Formal lectures/tutorials, which provide you with alternative explanations to aid your understanding. They also allow for exercises in problem solving and allow for time for you to resolve problems in understanding of lecture material;
- Design and simulation work, which supports the lecture video material and also provides you with skills necessary to perform a design task.

Learning in this course

You are expected to attend all lecture/tutorial classes in order to maximise learning. You **should** watch the relevant online lecture videos before attending the lecture/tutorial classes. 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 formal classes throughout the course.

Tutorial classes

Five to six tutorial sheets may be expected. The problem-solving sessions will be on most recently covered topics. Additionally, online PSIM or LTSpice sessions may be arranged. Students will be expected to participate vigorously during these sessions, in the form of questions, suggested solutions and methods. Participation by students and the tutor should be viewed as desirable aspects of these sessions.

You should attempt all of your problem sheet questions in advance of attending the tutorial classes. The

importance of adequate preparation prior to each tutorial cannot be overemphasized, as the effectiveness and usefulness of the tutorial depends to a large extent on this preparation. Group learning is encouraged. Answers for these questions will be discussed during the tutorial class and the tutor will cover the more complex questions in the tutorial class. In addition, during the tutorial class, 1-2 new questions that are not in your notes may be provided by the tutor, for you to try in class. These questions and solutions may not be made available on the web, so it is worthwhile for you to attend your tutorial classes to gain maximum benefit from this course.

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.

Assessment

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Assignment 2	10%	08/10/2021 03:00 PM	3, 4, 5, 6, 7
2. Assignment 1	10%	29/10/2021 03:00 PM	1, 2, 3
3. Assignment 3	20%	19/11/2021 03:00 PM	1, 2, 3, 4, 5, 6, 7, 8
4. Final Examination	60%	Not Applicable	1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Assessment 1: Assignment 2

Start date: 17/09/2021 12:00 AM
Submission notes: via Moodle
Due date: 08/10/2021 03:00 PM

Assignment based around first 3 weeks of topics.

Assessment criteria

The assignment will be marked in a similar way to an exam solution in a closed-book exam. This requires the student to provide sufficient working and/or development of the theory from first principles to demonstrate the depth of learning that the candidate has developed.

Additional details

You are required to submit this hand-in assignment for ELEC9711. The mark from this assignment will contribute to 10% of your final class mark. You are expected to submit this hand-in assignment using a PDF file via the **Assignment 1 link on the ELEC9711 Moodle page** before **3pm on the Friday of week 4 T3**. *Late submissions will not be accepted. You must include a signed cover sheet declaring that the work submitted is your own work and this must be the first page of the assignment: the cover sheet is available on the OpenLearning site alongside this assignment.*

Assessment 2: Assignment 1

Due date: 29/10/2021 03:00 PM

Assignment on 4th order circuits

Assessment criteria

The assignment will be marked in a similar way to an exam solution in a closed-book exam. This requires the student to provide sufficient working and/or development of the theory from first principles to demonstrate the depth of learning that the candidate has developed.

Assessment 3: Assignment 3

Start date: 05/11/2021 04:00 PM

Due date: 19/11/2021 03:00 PM

Assignment on selected topics covered in weeks 4-7

Assessment criteria

The assignment will be marked in a similar way to an exam solution in a closed-book exam. This requires the student to provide sufficient working and/or development of the theory from first principles to demonstrate the depth of learning that the candidate has developed.

Assessment 4: Final Examination

Final examination is two-hour written examination, comprising four questions from which students select to answer only three questions.

Attendance Requirements

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

Course Schedule

Period	Summary of Indicative Lecture Program
Week 1	Introduction to Course
Week 2	Hard-Switched DC-DC Converters; **Assignment 1 Released**
Week 3	Resonant-Switched DC-DC Converters
Week 4	Isolated DC-DC Converters; **Assignment 1 Due**
Week 5	Grid-Connected H-Bridge Converters; **Assignment 2 Released**
Week 6	Three-Phase Inverter Control
Week 7	Wind Energy Electrical Systems; **Assignment 2 Due**
Week 8	Photovoltaic Electrical Systems; **Assignment 3 Released**
Week 9	HVDC Transmission Systems
Week 10	Multi-Level Converters; **Assignment 3 Due**

View class timetable

Timetable

Date	Type	Content
Week 1: 13 September - 17 September	Online Activity	Introduction and review
Week 2: 20 September - 24 September	Online Activity	Hard switched dc-dc converters
Week 3: 27 September - 1 October	Online Activity	Resonant dc-dc converters
Week 4: 4 October - 8 October	Online Activity	Isolated dc-dc converters
Week 5: 11 October - 15 October	Online Activity	Grid-connected H-bridge converters
Week 6: 18 October - 22 October	Online Activity	Three phase inverter control
Week 7: 25 October - 29 October	Online Activity	Wind energy converters
Week 8: 1 November - 5 November	Online Activity	Photovoltaic inverters and control
Week 9: 8 November - 12 November	Online Activity	HVDC systems
Week 10: 15 November - 19 November	Online Activity	Multilevel converters

Study Week: 20 November - 25 November	Online Activity	

Resources

Recommended Resources

COURSE RESOURCES

Textbooks

Reference textbooks

1. N. Mohan, T. M. Undeland & W. P. Robins, “Power Electronics; Converters, Applications and Design”, John Wiley, Second Edition, 1995, New York.
2. J. G. Kassakian, M.F. Schlecht & G.C. Verghese, “Principles of Power Electronics”, Addison Wesley, 1991.
3. R. W. Erickson, "Fundamentals of Power Electronics”, Kluwer Academic Publications, 1997.
4. D. W. Hart, “Introduction to Power Electronics”, Prentice Hall International, 1997.

On-line resources

Lecture Content

Lecture videos and lecture notes written by the lecturer for each section will be available from the course webpage on Open Learning. These are based on the textbooks listed above and other reference material which will be cited within the lecture videos/notes.

All lecture videos, notes, assignments, tutorial and technical report topics for this course can be downloaded from the Open Learning website. Students will be expected to have watched the relevant lecture videos before class and have access to, or to bring printed, tutorial sheets to the tutorials.

Open Learning

As a part of the teaching component, Open Learning will be used to disseminate teaching materials, host forums and occasionally, quizzes. Assessment marks will also be made available via Open Learning: https://www.openlearning.com/unswcourses/courses/elec9711-2021.

Mailing list

Announcements concerning course information will be given in the lectures and/or on Open Learning and/or via email (which will be sent to your student email address).

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. This includes changing the content of the class to include more renewables and distributed generation and revising the assessment scheme. For the course delivered in 2017, the assessment schedule and weighting were adjusted such that the final

exam represents 60% of the final mark, with assignments and coursework representing 40% in total. In 2019, the course underwent digital uplift and received a huge investment in the production of online materials, key concept videos and podcasts. These were used in 2020 for the first time.

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. 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.

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.engineering.unsw.edu.au/electrical-engineering/resources

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	