



## UNSW Course Outline

# ELEC4614 Power Electronics - 2024

Published on the 13 Feb 2024

## General Course Information

**Course Code :** ELEC4614

**Year :** 2024

**Term :** Term 1

**Teaching Period :** T1

**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

Power electronic circuits are an essential requirement for renewables, energy storage, electric vehicles to name a few of the huge opportunities in the energy domain as well as for a whole array of consumer and industrial products. At the low power end, these may include switched-mode regulated power supplies for hand-held devices, TVs, light fittings, computers and other

entertainment systems. At the high power end, there are diverse industrial applications in high voltage DC transmission, grid connections for wind generators and PV systems; Power supplies for telecommunication equipment, welding, furnaces, and smelting; Power electronic converters for variable-speed drives in automotive and railway traction and accessories, in steel rolling, textile, paper rolling mills, machine tools, robotic, disk and other automation drives, ship propulsion and positioning, aircraft actuators and navigation. Electronic processing of electrical power for these applications also provides the means to control these processes to obtain certain desirable goals such as energy efficiency, better product quality and accurate control of the manufacturing.

## Course Aims

The course is intended for students who may want to work in environments where all aspects of the design, application and maintenance of power electronic converter circuits are envisaged. The course will familiarize students with the many diverse power semiconductor devices and their ancillary control circuits at both low and high power levels and prepare them with the requisite design and performance analysis skills for some of these circuits.

This course also aims to equip the student with a basic understanding of modern power semiconductor devices, their strengths, and their switching and protection techniques. These include power diodes, bipolar and MOSFET power transistors, other gate controlled devices such as thyristors, insulated-gate bipolar transistors (IGBT) and gate turn-off thyristors (GTO). Various important topologies of power converter circuits for specific types of applications are covered and analyzed. These include controlled and uncontrolled rectifiers, DC-DC converters and inverters. The course also equips student with ability to understand and analyze the qualities of waveforms at input and output ends of these converters. The quality of these waveforms is of major concern to users of modern power converter circuits and the utility authorities alike.

## Course Learning Outcomes

| Course Learning Outcomes   |
|--|
| CLO1 : Explain modern power semiconductor devices, their strengths, and their switching and protection techniques. These include power diodes, bipolar and MOSFET power transistors, other gate-controlled devices such as thyristors, insulated-gate bipolar transistors and gate turn-off thyristors |
| CLO2 : Explain the operation of and develop analysis skills for several important topologies of power converter circuits for specific types of applications. These include controlled and uncontrolled rectifiers, DC-DC converters and inverters.   |
| CLO3 : Analyse the qualities of waveforms at input and output ends of converters. The quality of these waveforms is of major concern to users of modern power converter circuits and the utility authorities alike.  |

| Course Learning Outcomes   | Assessment Item   |
|--|---|
| CLO1 : Explain modern power semiconductor devices, their strengths, and their switching and protection techniques. These include power diodes, bipolar and MOSFET power transistors, other gate-controlled devices such as thyristors, insulated-gate bipolar transistors and gate turn-off thyristors | <ul style="list-style-type: none"> <li>• Hand-in Assignment</li> <li>• Mid-term Test</li> <li>• Laboratory Work and Reports</li> <li>• Final Examination</li> </ul> |
| CLO2 : Explain the operation of and develop analysis skills for several important topologies of power converter circuits for specific types of applications. These include controlled and uncontrolled rectifiers, DC-DC converters and inverters.   | <ul style="list-style-type: none"> <li>• Hand-in Assignment</li> <li>• Mid-term Test</li> <li>• Laboratory Work and Reports</li> <li>• Final Examination</li> </ul> |
| CLO3 : Analyse the qualities of waveforms at input and output ends of converters. The quality of these waveforms is of major concern to users of modern power converter circuits and the utility authorities alike.  | <ul style="list-style-type: none"> <li>• Mid-term Test</li> <li>• Laboratory Work and Reports</li> <li>• Final Examination</li> </ul>                               |

## Learning and Teaching Technologies

Moodle - Learning Management System | OpenLearning

## Other Professional Outcomes

**Engineers Australia (EA), Professional Engineer Stage 1 Competencies**

The Course Learning Outcomes (CLOs) contribute to your development of the following EA competencies:

### PE1: Knowledge and Skill Base:

PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals: CLO 1, 2, 3

PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing: CLO 2

PE1.3 In-depth understanding of specialist bodies of knowledge: CLO 1, 2, 3

PE1.4 Discernment of knowledge development and research directions: n/a

PE1.5 Knowledge of engineering design practice: CLO 2, 3

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 2, 3

PE2.2 Fluent application of engineering techniques, tools and resources: CLO 2,3

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 2, 3

PE3.3 Creative, innovative and pro-active demeanour: CLO 3

PE3.4 Professional use and management of information: n/a

PE3.5 Orderly management of self, and professional conduct: CLO 1,3

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

## **Additional Course Information**

Other mattersRelationship of Assessment Methods to Learning Outcomes

Student Responsibilities and Conduct  
Plagiarism is the unacknowledged use of other people's work, including the copying of assignment works and laboratory results from other students. Plagiarism is considered a form of academic misconduct, and the University has very strict rules that include some severe penalties. For UNSW policies, penalties and information to help you avoid plagiarism, see <http://www.lc.unsw.edu.au/plagiarism>. To find out if you understand plagiarism correctly, try this short quiz: <https://student.unsw.edu.au/plagiarism-quiz>.

Students are expected to be familiar with and adhere to all UNSW policies (see <https://my.unsw.edu.au/student/atoz/ABC.html>), and particular attention is drawn to the following:

### **Keeping Informed**

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

## 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.

2015 feedback: As a result of previous feedback obtained for this course we replaced an existing laboratory exercise which students had found difficulty understanding (Unity-power factor converter) with one that demonstrates the detailed characteristics of semiconductor devices to enhance understanding of the switching transients of diodes, MOSFETs and IGBTs.

2016 feedback: Lab exercises 1, 2, and 3 have been modified to reduce the number of test results required to be taken. OpenLearning website developed.

2017 feedback: further modifications to lab exercises and development of the summer online course. Revised OpenLearning site developed based around topics.

2018 feedback: Revised OpenLearning site developed based around topics.

2019 feedback: Further OpenLearning site developments and adjustments for trimesters.

2020 feedback: Feedback on online-only delivery mode due to COVID-19 issues.

## Assessments

### Assessment Structure

| Assessment Item  | Weight | Relevant Dates |
|--|--------|----------------|
| Hand-in Assignment<br>Assessment Format: Individual          | 10%    |                |
| Mid-term Test<br>Assessment Format: Individual               | 10%    |                |
| Laboratory Work and Reports<br>Assessment Format: Individual | 20%    |                |
| Final Examination<br>Assessment Format: Individual           | 60%    |                |

# Assessment Details

## Hand-in Assignment

### Assessment Overview

This assignment, based around the first 3 weeks of topics, is a question that is similar to an exam grade question. It will be marked as such and students are expected to consider the development of the theory and the solution to the problem using theory, analysis and numerical solutions where necessary. The assignment has a marking scheme that students can see and that will guide them on the necessary substance of each sub-problem in the assignment. Class-wide feedback will be verbally given during a lecture session.

### Course Learning Outcomes

- CLO1 : Explain modern power semiconductor devices, their strengths, and their switching and protection techniques. These include power diodes, bipolar and MOSFET power transistors, other gate-controlled devices such as thyristors, insulated-gate bipolar transistors and gate turn-off thyristors
- CLO2 : Explain the operation of and develop analysis skills for several important topologies of power converter circuits for specific types of applications. These include controlled and uncontrolled rectifiers, DC-DC converters and inverters.

## Mid-term Test

### Assessment Overview

This assessment covers one or more of the material delivered in the first 6 weeks of lectures. It is a question that is similar to an exam grade question. It will be marked as such and students are expected to consider the development of the theory and the solution to the problem using theory, analysis and numerical solutions where necessary. It has a marking scheme that students can see and that will guide them on the necessary substance of each sub-problem in the assessment. Class-wide feedback will be verbally given during a lecture session.

### Course Learning Outcomes

- CLO1 : Explain modern power semiconductor devices, their strengths, and their switching and protection techniques. These include power diodes, bipolar and MOSFET power transistors, other gate-controlled devices such as thyristors, insulated-gate bipolar transistors and gate turn-off thyristors
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# Laboratory Work and Reports

## Assessment Overview

This lab work assignment, based on laboratory work selected topics covered in weeks 4-7, is a question that is similar to an exam grade question. It will be marked as such and students are expected to consider the development of the theory and the solution to the problem using theory, analysis and numerical solutions where necessary. The assignment has a marking scheme that students can see and that will guide them on the necessary substance of each sub-problem in the assignment. Class-wide feedback will be verbally given during a lecture session.

## Course Learning Outcomes

- CLO1 : Explain modern power semiconductor devices, their strengths, and their switching and protection techniques. These include power diodes, bipolar and MOSFET power transistors, other gate-controlled devices such as thyristors, insulated-gate bipolar transistors and gate turn-off thyristors
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# Final Examination

## Assessment Overview

The final examination is a two-hour written examination, comprising four questions from which students select to answer only three questions. Questions may be drawn from any aspect of the course (lectures and tutorials) unless specifically indicated otherwise by the lecturer. Marks will be assigned according to the correctness of the responses.

## Course Learning Outcomes

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# General Assessment Information

## Grading Basis

Standard

# Course Schedule

| Teaching Week/Module               | Activity Type | Content  |
|------------------------------------|---------------|--|
| Week 1 : 12 February - 18 February | Lecture       | <ul style="list-style-type: none"><li>• Introduction and start power semiconductor devices</li><li>• Losses and thermal design</li></ul> |
| Week 2 : 19 February - 25 February | Lecture       | <ul style="list-style-type: none"><li>• Diode rectifier circuits</li><li>• Single-phase thyristor rectifier circuits</li></ul>           |
| Week 3 : 26 February - 3 March     | Lecture       | <ul style="list-style-type: none"><li>• Full-wave and three-phase</li></ul>  |
| Week 4 : 4 March - 10 March        | Lecture       | <ul style="list-style-type: none"><li>• Buck converter analysis techniques</li></ul>   |
| Week 5 : 11 March - 17 March       | Lecture       | Boost, Buck-boost converter analysis   |
| Week 6 : 18 March - 24 March       | Homework      | REcharge week - no additional materials or new concepts - no lectures/labs/ workshop tutorials   |
| Week 7 : 25 March - 31 March       | Lecture       | <ul style="list-style-type: none"><li>• Flyback converter analysis</li></ul>   |
| Week 8 : 1 April - 7 April         | Lecture       | Forward converter analysis   |
| Week 9 : 8 April - 14 April        | Lecture       | Introduction to Single-phase DC-AC circuits.   |
| Week 10 : 15 April - 21 April      | Lecture       | Introduction to Three-phase DC-AC circuits.  |

## Attendance Requirements

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

## General Schedule Information

Up to 3 hours of lectures and/or workshops per week and labs from week 3.

# Course Resources

## Prescribed Resources

The course materials and digital media are mainly available on OpenLearning that can be accessed through the link on the front page/.

## Recommended Resources

Reading List:

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.

## Course Evaluation and Development

### 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.

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## Staff Details

| Position  | Name                | Email | Location    | Phone     | Availability | Equitable Learning Services Contact | Primary Contact |
|-----------|---------------------|-------|-------------|-----------|--------------|-------------------------------------|-----------------|
| Lecturer  | John Fletcher       |       | Rm 404, G17 | 293856007 |              | No                                  | Yes             |
| Convenor  | John Fletcher       |       | Rm 404, G17 | 293856007 |              | No                                  | No              |
| Lab staff | Gamini Liyadipitiya |       | Rm 115, G17 |           |              | 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 Plagiarism

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](http://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