ELEC395

Power Electronics

S1 Day 2018

Dept of Engineering

Contents

General Information

Unit convenor and teaching staff
A/Prof
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Thursday 11.00 AM-1.00 PM

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Credit points
3

Prerequisites
39cp at 100 level or above including ENGG150 and ELEC270

Corequisites

Co-badged status

Unit description
This unit develops fundamental knowledge and skills in the area of electronic power devices and circuits and their applications. Foundation knowledge in electronics and feedback control is assumed. This unit extends those fundamentals to electrical energy systems operating with relatively high current and/or high voltage. Topics covered include: Power electronic devices (semiconductor technologies, IGBTs, VMOS FETs, etc). AC/DC-DC/AC converters and inverters (buck, boost, buck-boost, DC and AC regulators, resonant converters). Motor drive and control (AC, DC), power factor control. Energy efficiency and management (conversion losses, maximum power point tracking, energy harvesting systems). Power combining techniques. Thermal management. Simulation tools (SPICE, PowerSim, etc). The concepts studied in this unit, and the knowledge and skills gained, are required in an advanced unit in the area of electrical and energy systems engineering.

Important Academic Dates

Information about important academic dates including deadlines for withdrawing from units are available at https://www.mq.edu.au/study/calendar-of-dates

Learning Outcomes

On successful completion of this unit, you will be able to:

Describe the relationship between physical structure and performance characteristics of passive electrical components and active semiconductor power electronic devices.

Analyse and simulate power electronic circuits and derive accepted performance parameters, including power quality metrics.

Design and critically assess key aspects of power converters such as rectifiers, DC-DC converters and DC-AC inverters

Research, design, construct and analyse a complete power conversion application based on a complex set of user specifications

Demonstrate knowledge of emerging applications of power electronics in the "smart grid", renewable energy systems, electrified transport, etc.

General Assessment Information

Conditions required to pass the unit**: e. g.: Grading and passing requirement for unit**

In order to pass this unit a student must obtain a mark of 50 or more for the unit (i.e. obtain a passing grade P/ CR/ D/ HD). For further details about grading, please refer below in the policies and procedures section.

Late submissions and Resubmissions

Late submissions will attract a penalty of 10/100, 10% marks per day. Extenuating circumstances will be considered upon lodgment of a formal notice of disruption of studies.

Resubmissions of work are not allowed.

Assessment Tasks

Name	Weighting	Hurdle	Due
End of semester examination	40%	No	Examination period
Design assignment	15%	No	Week 13

Name	Weighting	Hurdle	Due
Laboratory	35%	No	During semester
Tutorial assignment	10%	No	At the end of tute session

End of semester examination

Due: **Examination period**
Weighting: **40%**

End of semester examination. Details will be discussed in class.

On successful completion you will be able to:

- Describe the relationship between physical structure and performance characteristics of passive electrical components and active semiconductor power electronic devices.
- Design and critically assess key aspects of power converters such as rectifiers, DC-DC converters and DC-AC inverters
- Demonstrate knowledge of emerging applications of power electronics in the "smart grid", renewable energy systems, electrified transport, etc.

Design assignment

Due: **Week 13**
Weighting: **15%**

A substantial design assignment to be completed over the course of the semester. Details will be provided via the iLearn website, and discussed in class.

On successful completion you will be able to:

- Analyse and simulate power electronic circuits and derive accepted performance parameters, including power quality metrics.
- Design and critically assess key aspects of power converters such as rectifiers, DC-DC converters and DC-AC inverters
- Research, design, construct and analyse a complete power conversion application based on a complex set of user specifications

Laboratory

Due: **During semester**
Weighting: **35%**

Experimental tasks to be completed in the laboratory will be set most weeks during semester, together with associated readings and prework. These will be marked in the laboratory. Details of

laboratory pre-work and tasks will be provided in class and via the iLearn website. **No lab class will be held in week 1.**

On successful completion you will be able to:

- Analyse and simulate power electronic circuits and derive accepted performance parameters, including power quality metrics.
- Demonstrate knowledge of emerging applications of power electronics in the "smart grid", renewable energy systems, electrified transport, etc.

Tutorial assignment

Due: **At the end of tute session**
Weighting: **10%**

A set of tutorial problems will be assigned for completion during the tutorial class. Details will be provided in class and via the iLearn website. **No tutorial class will be held in week 1.**

On successful completion you will be able to:

- Describe the relationship between physical structure and performance characteristics of passive electrical components and active semiconductor power electronic devices.
- Design and critically assess key aspects of power converters such as rectifiers, DC-DC converters and DC-AC inverters

Delivery and Resources

Learning in this unit is focused around weekly laboratory-based activities, investigating the properties and applications of power electronics components, circuits, and systems used in modern electrical energy systems. Weekly classes will support the development of learning outcomes.

Technology used: electronic and electrical instruments, software for circuit simulation and circuit board design (ORCAD). Access to these resources will be available in the laboratory during scheduled sessions.

All resources and links to relevant information will be provided via the ELEC395 iLearn webpage.

Unit Schedule

For details, please refer to the Unit Schedule on the ELEC395 iLearn webpage.

Learning and Teaching Activities

Unit Schedule

Weekly learning and teaching topics and activities are outlined in the Unit Schedule, together

with relevant sections of the text and references.

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central). Students should be aware of the following policies in particular with regard to Learning and Teaching:

- Academic Appeals Policy
- Academic Integrity Policy
- Academic Progression Policy
- Assessment Policy
- Fitness to Practice Procedure
- Grade Appeal Policy
- Complaint Management Procedure for Students and Members of the Public
- Special Consideration Policy *(**Note:** The Special Consideration Policy is effective from 4 December 2017 and replaces the Disruption to Studies Policy.)*

Undergraduate students seeking more policy resources can visit the Student Policy Gateway (https://students.mq.edu.au/support/study/student-policy-gateway). It is your one-stop-shop for the key policies you need to know about throughout your undergraduate student journey.

If you would like to see all the policies relevant to Learning and Teaching visit Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central).

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/study/getting-started/student-conduct

Results

Results shown in *iLearn*, or released directly by your Unit Convenor, are not confirmed as they are subject to final approval by the University. Once approved, final results will be sent to your student email address and will be made available in eStudent. For more information visit ask.mq.edu.au.

Student Support

Macquarie University provides a range of support services for students. For details, visit http://students.mq.edu.au/support/

Learning Skills

Learning Skills (mq.edu.au/learningskills) provides academic writing resources and study strategies to improve your marks and take control of your study.

- Workshops
- StudyWise
- Academic Integrity Module for Students
- Ask a Learning Adviser

Student Services and Support

Students with a disability are encouraged to contact the Disability Service who can provide appropriate help with any issues that arise during their studies.

Student Enquiries

For all student enquiries, visit Student Connect at ask.mq.edu.au

IT Help

For help with University computer systems and technology, visit http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/.

When using the University's IT, you must adhere to the Acceptable Use of IT Resources Policy. The policy applies to all who connect to the MQ network including students.

Graduate Capabilities

Creative and Innovative

Our graduates will also be capable of creative thinking and of creating knowledge. They will be imaginative and open to experience and capable of innovation at work and in the community. We want them to be engaged in applying their critical, creative thinking.

This graduate capability is supported by:

Learning outcomes

- Analyse and simulate power electronic circuits and derive accepted performance parameters, including power quality metrics.
- Design and critically assess key aspects of power converters such as rectifiers, DC-DC converters and DC-AC inverters
- Research, design, construct and analyse a complete power conversion application based on a complex set of user specifications

Assessment task

- Design assignment

Learning and teaching activity

- Weekly learning and teaching topics and activities are outlined in the Unit Schedule, together with relevant sections of the text and references.

Capable of Professional and Personal Judgement and Initiative

We want our graduates to have emotional intelligence and sound interpersonal skills and to demonstrate discernment and common sense in their professional and personal judgement. They will exercise initiative as needed. They will be capable of risk assessment, and be able to handle ambiguity and complexity, enabling them to be adaptable in diverse and changing environments.

This graduate capability is supported by:

Learning outcomes

- Describe the relationship between physical structure and performance characteristics of passive electrical components and active semiconductor power electronic devices.
- Analyse and simulate power electronic circuits and derive accepted performance parameters, including power quality metrics.
- Design and critically assess key aspects of power converters such as rectifiers, DC-DC converters and DC-AC inverters
- Research, design, construct and analyse a complete power conversion application based on a complex set of user specifications
- Demonstrate knowledge of emerging applications of power electronics in the "smart grid", renewable energy systems, electrified transport, etc.

Assessment tasks

- End of semester examination
- Design assignment
- Laboratory
- Tutorial assignment

Learning and teaching activities

- Weekly learning and teaching topics and activities are outlined in the Unit Schedule, together with relevant sections of the text and references.

Commitment to Continuous Learning

Our graduates will have enquiring minds and a literate curiosity which will lead them to pursue knowledge for its own sake. They will continue to pursue learning in their careers and as they participate in the world. They will be capable of reflecting on their experiences and relationships with others and the environment, learning from them, and growing - personally, professionally and socially.

This graduate capability is supported by:

Assessment tasks

- Design assignment
- Laboratory
- Tutorial assignment

Learning and teaching activities

- Weekly learning and teaching topics and activities are outlined in the Unit Schedule, together with relevant sections of the text and references.

Discipline Specific Knowledge and Skills

Our graduates will take with them the intellectual development, depth and breadth of knowledge, scholarly understanding, and specific subject content in their chosen fields to make them competent and confident in their subject or profession. They will be able to demonstrate, where relevant, professional technical competence and meet professional standards. They will be able to articulate the structure of knowledge of their discipline, be able to adapt discipline-specific knowledge to novel situations, and be able to contribute from their discipline to inter-disciplinary solutions to problems.

This graduate capability is supported by:

Learning outcomes

- Describe the relationship between physical structure and performance characteristics of passive electrical components and active semiconductor power electronic devices.
- Analyse and simulate power electronic circuits and derive accepted performance parameters, including power quality metrics.
- Design and critically assess key aspects of power converters such as rectifiers, DC-DC converters and DC-AC inverters
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Assessment tasks

- End of semester examination
- Design assignment
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- Tutorial assignment

Learning and teaching activities

- Weekly learning and teaching topics and activities are outlined in the Unit Schedule,

together with relevant sections of the text and references.

Critical, Analytical and Integrative Thinking

We want our graduates to be capable of reasoning, questioning and analysing, and to integrate and synthesise learning and knowledge from a range of sources and environments; to be able to critique constraints, assumptions and limitations; to be able to think independently and systemically in relation to scholarly activity, in the workplace, and in the world. We want them to have a level of scientific and information technology literacy.

This graduate capability is supported by:

Learning outcomes

- Analyse and simulate power electronic circuits and derive accepted performance parameters, including power quality metrics.
- Design and critically assess key aspects of power converters such as rectifiers, DC-DC converters and DC-AC inverters
- Research, design, construct and analyse a complete power conversion application based on a complex set of user specifications

Assessment tasks

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- Design assignment
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Learning and teaching activities

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Problem Solving and Research Capability

Our graduates should be capable of researching; of analysing, and interpreting and assessing data and information in various forms; of drawing connections across fields of knowledge; and they should be able to relate their knowledge to complex situations at work or in the world, in order to diagnose and solve problems. We want them to have the confidence to take the initiative in doing so, within an awareness of their own limitations.

This graduate capability is supported by:

Learning outcomes

- Analyse and simulate power electronic circuits and derive accepted performance parameters, including power quality metrics.
- Design and critically assess key aspects of power converters such as rectifiers, DC-DC

converters and DC-AC inverters
- Research, design, construct and analyse a complete power conversion application based on a complex set of user specifications

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- Tutorial assignment

Learning and teaching activities

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Effective Communication

We want to develop in our students the ability to communicate and convey their views in forms effective with different audiences. We want our graduates to take with them the capability to read, listen, question, gather and evaluate information resources in a variety of formats, assess, write clearly, speak effectively, and to use visual communication and communication technologies as appropriate.

This graduate capability is supported by:

Learning outcomes

- Analyse and simulate power electronic circuits and derive accepted performance parameters, including power quality metrics.
- Design and critically assess key aspects of power converters such as rectifiers, DC-DC converters and DC-AC inverters
- Research, design, construct and analyse a complete power conversion application based on a complex set of user specifications

Assessment tasks

- End of semester examination
- Design assignment
- Laboratory
- Tutorial assignment

Learning and teaching activities

- Weekly learning and teaching topics and activities are outlined in the Unit Schedule, together with relevant sections of the text and references.

Socially and Environmentally Active and Responsible

We want our graduates to be aware of and have respect for self and others; to be able to work with others as a leader and a team player; to have a sense of connectedness with others and country; and to have a sense of mutual obligation. Our graduates should be informed and active participants in moving society towards sustainability.

This graduate capability is supported by:

Learning and teaching activities

- Weekly learning and teaching topics and activities are outlined in the Unit Schedule, together with relevant sections of the text and references.

Changes from Previous Offering

The feedback from previous cohort of students was that they would benefit from timely feedback and providing a single textbook. The convenor will provide timely feedback on assessment items and provide a single textbook for this unit.