ELEC395

Power Electronics

S1 Day 2019

School of Engineering

Contents

General Information

Unit convenor and teaching staff
Senior Lecturer in Electrical Engineering
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Thursday 2:00 PM - 4:00 PM

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 AC-DC, DC-DC and DC-AC converters;
- Design, build and analyse a complete power converter application based on a set of user specifications;
- Demonstrate knowledge of emerging applications of power electronics in the renewable energy systems, energy storage systems and micro-grids;
- Demonstrate foundational learning skills including active engagement in their learning process.

General Assessment Information

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, or HD).
- For further details about grading, please refer below in the policies and procedures section.
- If you receive special consideration for the oral presentation and demonstration of the project, a supplementary conventional exam will be scheduled by the faculty during a supplementary exam period, typically about 3 to 4 weeks after the normal exam period. By making a special consideration application for the oral presentation and demonstration of the project you are declaring yourself available for a conventional exam during the supplementary examination period and will not be eligible for a second special consideration approval based on pre-existing commitments. Please ensure you are familiar with the policy prior to applying. Approved applicants will receive an individual notification one week prior to the exam with the exact date and time of their supplementary examination.

Hurdle Requirements

- Students must attend and participate in at least **9 of the 12 weekly laboratoriess** (Week 2 to Week 13) to pass this unit.

Late Submissions and Resubmissions

- Late report submissions will attract a penalty of <10/100, 10%> marks per day. Extenuating circumstances will be considered upon lodgement of an application for special consideration.

- Resubmissions of work are not allowed.

Students are reminded of the University policies regarding assessment, academic honesty and disruption to studies.

Requests for extension on assessable work are to be made to the Unit Coordinator but will only be considered in the event of illness or misadventure.

Assessment Tasks

Name	Weighting	Hurdle	Due
Lectorial assessment	25%	No	Week 2 to Week 12
Laboratory assessment	25%	Yes	Week 2 to Week 13
Project assessment	50%	No	see iLearn for unit schedule

Lectorial assessment

Due: **Week 2 to Week 12**
Weighting: **25%**

In class evaluation of students actively participating in Lectorials from Week 2 to Week 12. Students are awarded marks for answering questions and solving problems on paper and/or whiteboard.

More details about marking will be presented in Intro session 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;
- - Demonstrate knowledge of emerging applications of power electronics in the renewable energy systems, energy storage systems and micro-grids;

Laboratory assessment

Due: **Week 2 to Week 13**
Weighting: **25%**
This is a hurdle assessment task (see assessment policy for more information on hurdle assessment tasks)

Evaluation of Lab activity during semester starting from Week 2 to Week 13. This evaluation focuses on students' ability to perform modelling, design and implementation of power electronics systems using PLECS, MATLAB/Simulink and Arduino board.

- Evaluation of individual work (Week 2 to Week 7);
- Evaluation of team work (Week 8 to Week 13);
- Students must attend 9 of the 12 weekly laboratories. This is a hurdle requirement.

Students consistently helping their team members or other team members are awarded bonus marks.

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;
- - 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 AC-DC, DC-DC and DC-AC converters;
- - Demonstrate foundational learning skills including active engagement in their learning process.

Project assessment

Due: **see iLearn for unit schedule**
Weighting: **50%**

The major assessment of this Unit is for the team project. This will consist of 3 individual assessments and 1 team assessment:

- Individual assessments
    - Oral presentation and demonstration of the project (as per exam schedule);
    - Peer assessment regarding the actual contribution of each team member (Week 13);
    - Evaluation of project log book of each team member (Week 13).
- Team assessment
    - Project report to be submitted in iLearn by each team (end of Week 13).

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;
- - Analyse and simulate power electronic circuits and derive accepted performance parameters, including power quality metrics;
- - Design, build and analyse a complete power converter application based on a set of user specifications;

- - Demonstrate knowledge of emerging applications of power electronics in the renewable energy systems, energy storage systems and micro-grids;
- - Demonstrate foundational learning skills including active engagement in their learning process.

Delivery and Resources

UNIT WEBSITE

The iLearn website for this unit can be found at: https://ilearn.mq.edu.au/login/MQ/

All information and communications relevant to this unit will be via the iLearn website.

TEXTBOOK

- Power Electronics: Converters, Applications, and Design, Ned Mohan at all, 3rd edition, ISBN: 9780471226932 (recommended).
    - Please visit http://www.wiley.com/college/mohan for additional information.

All students are expected to have access to this textbook. The problems to be solved during the lectorials will be taken from this textbook.

LECTORIALS

The lectorials are organised in a flipped classroom fashion:

- Outside class
    - brief videos and/or lecture notes are posted in iLearn each week;
    - students are expected to watch these videos and/or read any posted notes prior to attending the lectorial.
- Inside class
    - discussion session on fundamental knowledge;
    - plenty of practical examples;
    - interactive problem solving involving the students.

PROJECTS

The project is the core component of this unit. The projects will cover practical aspects of power converter systems to be used in future Electrical units.

- Students are required to form teams (in Week 2) and each team will choose one project topic (in Week 3) from a given list of projects;
- All laboratory and project activities are performed in teams;
- Students are expected to use at least 1/3 of the unit hours working on the project, with more effort expected towards the second half of the semester.

LABORATORIES

- Laboratory activities start from Week 2;
- Interactive Labs use PLECS and are correlated with the problems solved during the lectorials and project topics;
- Experimental Labs are also available, where students will build and test simple power electronics converters and use Arduino control boards and Simulink to generate various gate signals;
- All laboratory activities are to be performed in the same teams as for projects;
- *Food and drink are not permitted in the laboratory, nor are students with bare feet, sandals or thongs. Students not complying with these regulations will be removed from the laboratory.*

TECHNOLOGY

- The laboratory work will rely on the use of PLECS and MATLAB/Simulink;
- The software is available through iLab and/or on Faculty computers;
- Each team will be given an Arduino kit for the second half of the semester to perform the experimental activities.

COMMUNICATIONS

- Students are reminded the University will communicate all official notices to you by email to your university email account. Please read your @student.mq.edu.au email regularly or forward it to an account you do read regularly.
- All announcements and other communications regarding this unit will be via iLearn.

REFERENCE BOOKS

- Power Electronics Handbook Hardcover, Muhammad H. Rashid, 4th edition, BH, ISBN: 978012811407;
- Fundamentals of Power Electronics, Robert W. Erickson, Dragan Maksimovic, 2nd edition, Springer, ISBN: 9780306480485.

WEB RESOURCES

- **PLECS support:**
    - https://plexim.com/support
        - PLECS videos;
        - Application examples;
        - Technical solutions;
        - Installation help.
- **MathWorks Website (MATLAB, Simulink, user-guides, tutorials, etc):**

- MATLAB Courseware
  - https://au.mathworks.com/academia/courseware.html
- MATLAB/Simulink Training for Macquarie University Students
  - https://trainingenrollment.mathworks.com/selfEnrollment?code=TSH4E9QU6C9G

Unit Schedule

Refer to iLearn website and lecture notes for the unit schedule.

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 published on platform other than eStudent, (eg. iLearn, Coursera etc.) 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 or if you are a Global MBA

student contact globalmba.support@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

If you are a Global MBA student contact globalmba.support@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 AC-DC, DC-DC

and DC-AC converters;
- - Design, build and analyse a complete power converter application based on a set of user specifications;

Assessment task

- Project assessment

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 AC-DC, DC-DC and DC-AC converters;
- - Design, build and analyse a complete power converter application based on a set of user specifications;
- - Demonstrate knowledge of emerging applications of power electronics in the renewable energy systems, energy storage systems and micro-grids;
- - Demonstrate foundational learning skills including active engagement in their learning process.

Assessment tasks

- Laboratory assessment
- Project assessment

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 task

- Project assessment

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;
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- - Demonstrate foundational learning skills including active engagement in their learning process.

Assessment tasks

- Lectorial assessment
- Laboratory assessment
- Project assessment

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 AC-DC, DC-DC and DC-AC converters;
- - Design, build and analyse a complete power converter application based on a set of user specifications;

Assessment tasks

- Lectorial assessment
- Laboratory assessment
- Project assessment

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 AC-DC, DC-DC and DC-AC converters;
- - Design, build and analyse a complete power converter application based on a set of user specifications;

Assessment tasks

- Lectorial assessment
- Laboratory assessment
- Project assessment

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 AC-DC, DC-DC and DC-AC converters;
- - Design, build and analyse a complete power converter application based on a set of user specifications;

Assessment tasks

- Lectorial assessment
- Project assessment

Engaged and Ethical Local and Global citizens

As local citizens our graduates will be aware of indigenous perspectives and of the nation's historical context. They will be engaged with the challenges of contemporary society and with knowledge and ideas. We want our graduates to have respect for diversity, to be open-minded, sensitive to others and inclusive, and to be open to other cultures and perspectives: they should have a level of cultural literacy. Our graduates should be aware of disadvantage and social justice, and be willing to participate to help create a wiser and better society.

This graduate capability is supported by:

Assessment task

- Project assessment

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:

Assessment task

- Project assessment

Changes from Previous Offering

This unit has been redeveloped to incorporate:

- in-class problem solving during lectorials;
- in-class students' evaluation during lectorials and laboratories;
- laboratory and project activities in teams;
- oral examination and demonstration of project work.