Power Electronics - Course Outline

ECEN 405: 2010 Trimester 1

This document sets out the workload and assessment requirements for ECEN 405. It also provides contact information for staff involved in the course. If the contents of this document are altered during the course, you will be advised of the change by an announcement in lectures and/or on the course web site. A printed copy of this document is held in the School Office.

Lecturer and Laboratory Demonstrator

The course lecturer is Professor Dale Carnegie, Office MD 224, Telephone: 463-7485, Email: [dale.carnegie@vuw.ac.nz and Dr Robin Dykstra, Office AM226, Telephone: 463-7508, Email: robin.dykstra@vuw.ac.nz. Ben Drayton, a PhD student will coordinate the laboratory work.

Objectives

On completing ECEN 405, a student should:

- 1. Understand the different power switching devices available including Power MOSFETs, BJTs, IGBTs, Thyristors, Triacs. The student should be able to select a device appropriate to the design current, voltage and frequency specifications.
- 2. Understand the terminology inherent in Power Electronics and be able to calculate figures of merit such as THD (both voltage and current), FF, CF, ripple, etc.
- 3. Understand and be able to practically implement different rectification techniques. The student should appreciate the advantages/disadvantages of each technique, and be able to make an appropriate design decision for a specific electronic application.
- 4. Be able to understand the function and applicability of a wide range of dc-dc converters including Buck, Boost, Buck-boost, Cuk, Forward, Flyback, Push-Pull Bridge and resonant converter techniques. The student should appreciate the advantages/disadvantages of each technique, and be able to make an appropriate design decision for a specific electronic application.
- 5. Understand the design issues for an inverter circuit including an appreciation of how different design topologies affect the resulting harmonics.
- 6. Appreciate at both a theoretical and practical level, the protective devices necessary when switching inductive loads.
- 7. Appreciate at both a theoretical and practical level, driver circuits required to interface to power switching devices.
- 8. Be able to implement an effective power control circuit for a dc motor, especially utilising the H-Bridge configurations.
- 9. Provide an oral presentation during the course dealing with a specified topic in Power Electronics. They will be required to answer questions from their peers and the course instructors.
- 10. Provide appropriate written documentation to support the practical assessment items in the course. Specifically they will be required to report on the justification for their design methodology, an explanation of the functioning of their circuit, and an evaluation of their working solution.

There will be two tests designed to assess analytical skills and the knowledge base of students (objectives 1-8). The laboratory part of the course assessment is designed to test the student's ability to design and debug power electronic circuits (objective 10), to maintain a reliable laboratory notebook, and to report in written form on their design work (objective 10). The assessment will cumulate with the design of a class D amplifier for sub-woofer frequencies.

Course Material and Textbook

For the Carnegie lectures, students will be provided with a comprehensive study guide which contains all the lecture OHTs but with blanks that will need to be filled-in during the lectures. A complete pdf of these slides is available via BlackBoard for students who have either missed the lecture or wish to have the material entered in advance. Dykstra will provide his notes during the lectures.

Laboratory exercises will be distributed in class. The level of difficulty in these exercises increases with each lab session, cumulating in the final Class D amplifier design as explained previously.

The required text book is:

Mohan, Undeland, Robins, “Power Electronics, Converters, Applications and Design”, 3rd edition, Wiley.

Lectures, Tutorials, Laboratories, and Practical work

Lectures for ECEN 405 are:

Monday, 1:00 pm – 2.00 pm in Cotton 523.

Wednesday, 4:00 - 5.00 pm in Cotton 523.

Friday, 10:00 - 11:00 am, in Cotton 523.

Lecture Topics

An approximate lecture schedule is as follows:

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- 1 Introduction
- 2 Power Devices I
- 3 Power Devices II
- 4 Computation Techniques and Conventions
- 5 Rectification I
- 6 Rectification II
- 7 Rectification III
- 8 Converters I
- 9 Converters II
- 10 Isolated Power Converters I
- 11 Isolated Power Converters II
- 12 Review and Catch-up
- 13 TEST
- 14 Inverters I
- 15 Inverters II
- 16 Drive Circuits
- 17 Snubbers
- 18 Resonant Converters I
- 19 Resonant Converters II
- 20 Motor Driver Circuits I
- 21 Motor Driver Circuits II
- 22 Test 2

Note this schedule is subject to change, depending on progress through the material.

Laboratories

The course includes five 3-hour experiments and one major practical assignment design exercises.

Laboratory sessions will be scheduled in the first week of term and will commence in the second week. The laboratory sessions will be held in Co250.

Laboratory Reports

You are required to submit a formal laboratory report for each of the assigned labs. These should be of professional standard detailing the objective of the laboratory exercise, the methodology employed, a justification for any design decisions, results obtained and an analysis or evaluation of your results. You should answer any questions asked of you in the laboratory manual.

Workload

The expectation is that you will do roughly 10 hours of work per week on average. This will normally comprise 2 hours of lectures, 1 hour tutorial, 3 – 4 hours of laboratory work, and an average of 3 – 4 hours of assignment work, laboratory write-ups, and background reading.

Announcements and Communication

The main means of communication outside of lectures will be the ECEN 405 entry on BlackBoard. Students should monitor BlackBoard rather than any ECS site.

Assessment

The course is entirely internally assessed (there is no formal examination), detailed as follows:

7.5% Assignment 1

7.5% Assignment 2

15% Assignment 3 and oral presentation

15% Term test 1

15% Term test 2

10% Assigned laboratory experiments

30% Class D amplifier design project

Late assessment will be penalised at the rate of 5% for every day the assessment is late. The lecturer may refuse to mark work that has been handed in over a week late, and may also refuse if the assessment has been marked and returned to the class. In such instances, a zero grade for that assessment shall result.

Mandatory Requirements

1. It is expected that ALL work will be completed and handed in for marking. An incomplete or fail grade will be issued to any student who satisfies ANY of the below requirements
    1. Satisfactorily completes less than 3 of the 5 assigned labs (a demonstrator must verify all lab work).
    2. Does not turn up for either of the two assigned internal tests
    3. Hands in less than 2 assignments
    4. Is caught cheating in any form (this includes laboratory work)
    5. Scores less than 40% on **both** the internal tests

Plagiarism

Working Together and Plagiarism

We encourage you to discuss the principles of the course and assignments with other students, to help and seek help with programming details, problems involving the lab machines. However, any work you hand in must be your own work.

The School policy on Plagiarism (claiming other people's work as your own) is available from the course home page. Please read it. We will penalise anyone we find plagiarising, whether from students currently doing the course, or from other sources. Students who knowingly allow other students to copy their work may also be penalised. If you have had help from someone else (other than a tutor), it is always safe to state the help that you got. For example, if you had help from someone else in writing a component of your code, it is not plagiarism as long as you state (eg, as a comment in the code) who helped you in writing the method.

Passing ECEN 405

To pass ECEN 405, a student must satisfy mandatory requirements and gain at least a **C** grade overall.

School of Engineering and Computer Science

The School office is located on level three of the Cotton Building (Cotton 358).

Withdrawal

The last date for withdrawal from ECEN 405 with entitlement to a refund of tuition fees is Fri 12 March 2010. The last date for withdrawal without being regarded as having failed the course is Fri 14 May 2010 -- though later withdrawals may be approved by the Dean in special circumstances.

Rules & Policies

Find key dates, explanations of grades and other useful information at http://www.victoria.ac.nz/home/study.

Find out about academic progress and restricted enrolment at http://www.victoria.ac.nz/home/study/academic-progress.

The University's statutes and policies are available at http://www.victoria.ac.nz/home/about/policy, except qualification statutes, which are available via the Calendar webpage at http://www.victoria.ac.nz/home/study/calendar (See Section C).

Further information about the University's academic processes can be found on the website of the Assistant Vice-Chancellor (Academic) at http://www.victoria.ac.nz/home/about/avcacademic

All students are expected to be familiar with the following regulations and policies, which are available from the school web site:

Grievances
Student and Staff Conduct
Meeting the Needs of Students with Disabilities
Student Support

Academic Support
Academic Integrity and Plagiarism
Dates and Deadlines including Withdrawal dates
School Laboratory Hours and Rules
Printing Allocations
Expectations of Students in ECS courses

The School of Engineering and Computer Science strives to anticipate all problems associated with its courses, laboratories and equipment. We hope you will find that your courses meet your expectations of a quality learning experience.

If you think we have overlooked something or would like to make a suggestion feel free to talk to your course organiser or lecturer.