ENAX12001 *Power Electronics Applications*
Term 1 - 2023

Profile information current as at 06/05/2024 02:30 pm

General Information

Overview

In this unit, you will learn to select power electronics solutions for industrial problems and simulate selected power electronic circuits. You will also learn the practical applications of power electronics circuits in complex systems such as renewable energy integration and electric/hybrid vehicle energy management systems. This unit is based on your knowledge of electronics and electrical machines you previously studied. In this unit, you will learn about power semiconductors such as Diacs, silicon controlled rectifiers (SCR), metal oxide silicon field-effect transistors (MOSFET), isolated gate bipolar junction transistors (IGBT), their symbols, and theory of operation and limitations. You will be introduced to the concepts DC to DC, and DC to AC circuits, and pulse width modulation (PWM) control circuits. You will also learn about different types of motor control and drive systems including DC motor control, AC motor control, and stepper motor control schemes. Students enrolled in online mode are required to attend a compulsory residential school.

Details

Career Level: *Undergraduate*
Unit Level: *Level 2*
Credit Points: *6*
Student Contribution Band: *8*
Fraction of Full-Time Student Load: *0.125*

Pre-requisites or Co-requisites

Prerequisites: ENEX12002 Introductory Electronics OR (ENEE13018 Analogue Electronics and ENEE13020 Digital Electronics) AND (ENEX12001 Electrical Power and Machines OR ENEE12015 Electrical Power Engineering)
Important note: Students enrolled in a subsequent unit who failed their pre-requisite unit, should drop the subsequent unit before the census date or within 10 working days of Fail grade notification. Students who do not drop the unit in this timeframe cannot later drop the unit without academic and financial liability. See details in the Assessment Policy and Procedure (Higher Education Coursework).

Offerings For Term 1 - 2023

- Mixed Mode

Attendance Requirements

All on-campus students are expected to attend scheduled classes – in some units, these classes are identified as a mandatory (pass/fail) component and attendance is compulsory. International students, on a student visa, must maintain a full time study load and meet both attendance and academic progress requirements in each study period (satisfactory attendance for International students is defined as maintaining at least an 80% attendance record).

Residential Schools

This unit has a Compulsory Residential School for distance mode students and the details are:
Click here to see your Residential School Timetable.

Website

This unit has a website, within the Moodle system, which is available two weeks before the start of term. It is important that you visit your Moodle site throughout the term. Please visit Moodle for more information.

Class and Assessment Overview

Recommended Student Time Commitment

Each 6-credit Undergraduate unit at CQUniversity requires an overall time commitment of an average of 12.5 hours of study per week, making a total of 150 hours for the unit.

Class Timetable

Regional Campuses
Bundaberg, Cairns, Emerald, Gladstone, Mackay, Rockhampton, Townsville

Metropolitan Campuses
Adelaide, Brisbane, Melbourne, Perth, Sydney

Assessment Overview

1. **Written Assessment**
Weighting: 20%
2. **In-class Test(s)**
Weighting: 20%
3. **Practical and Written Assessment**
Weighting: 20%
4. **Take Home Exam**
Weighting: 40%

Assessment Grading

This is a graded unit: your overall grade will be calculated from the marks or grades for each assessment task, based on the relative weightings shown in the table above. You must obtain an overall mark for the unit of at least 50%, or an overall grade of 'pass' in order to pass the unit. If any 'pass/fail' tasks are shown in the table above they must also be completed successfully ('pass' grade). You must also meet any minimum mark requirements specified for a particular assessment task, as detailed in the 'assessment task' section (note that in some instances, the minimum mark for a task may be greater than 50%). Consult the University's Grades and Results Policy for more details of interim results and final grades.

CQUniversity Policies

All University policies are available on the CQUniversity Policy site.
You may wish to view these policies:

- Grades and Results Policy
- Assessment Policy and Procedure (Higher Education Coursework)
- Review of Grade Procedure
- Student Academic Integrity Policy and Procedure
- Monitoring Academic Progress (MAP) Policy and Procedure – Domestic Students
- Monitoring Academic Progress (MAP) Policy and Procedure – International Students
- Student Refund and Credit Balance Policy and Procedure
- Student Feedback – Compliments and Complaints Policy and Procedure
- Information and Communications Technology Acceptable Use Policy and Procedure

This list is not an exhaustive list of all University policies. The full list of University policies are available on the CQUniversity Policy site.

Previous Student Feedback

Feedback, Recommendations and Responses

Every unit is reviewed for enhancement each year. At the most recent review, the following staff and student feedback items were identified and recommendations were made.

Feedback from Email

Feedback

The unit helps students develop useful skills applicable to power electronics in industry settings.

Recommendation

Continue to help students develop good practical and analyticsl skills in power electronics applications, reinforced by laboratory work.

Unit Learning Outcomes

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

1. Explain the construction of power semiconductor devices, their principle of operation, and their suitability for various switching functions
2. Compare and select power electronic components, converters, and drives for renewable energy integration and electric vehicles
3. Analyse and model the operation of single-phase and three-phase power electronic circuits, including alternating current (AC) to direct current (DC), AC to AC, DC to DC, and DC to AC topologies
4. Analyse variable speed motor drives and controllers for different types of electric motors and evaluate their performances
5. Work collaboratively and autonomously, and communicate professionally using power electronics terminology in presenting your solutions.

The Learning Outcomes for this unit are linked with the Engineers Australia Stage 1 Competency Standards for Professional Engineers in the areas of 1. Knowledge and Skill Base, 2. Engineering Application Ability and 3. Professional and Personal Attributes at the following levels:

Intermediate 1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline. (LO: 1N 2N 3I 4I 5I) 1.4 Discernment of knowledge development and research directions within the engineering discipline. (LO: 1N 2I 3I 4I 5I) 1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline. (LO: 2I 3I 4I 5I) 2.4 Application of systematic approaches to the conduct and management of engineering projects. (LO: 3I 4I 5I) 3.1 Ethical conduct and professional accountability. (LO: 1N 2I 4I) 3.2 Effective oral and written communication in professional and lay domains. (LO: 1N 2I 3I 4I 5I) 3.3 Creative, innovative and pro-active demeanour. (LO: 1N 2I 3I 4I 5I) 3.4 Professional use and management of information. (LO: 1N 2I 3I 4I 5I) 3.5 Orderly management of self, and professional conduct. (LO: 1I 2I 3I 4I 5I)

Advanced 1.1 Comprehensive, theory-based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline. (LO: 1N 2I 3A 4A 5I) 1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline. (LO: 1N 2I 3A 4A 5I) 1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline. (LO: 2A 3A 4A) 2.1 Application of established engineering methods to complex engineering problem solving. (LO: 1I 2I 3A 4A 5I) 2.2 Fluent application of engineering techniques, tools and resources. (LO: 1I 2I 3A 4A 5A) 2.3 Application of systematic engineering synthesis and design processes. (LO: 1I 2I 3A 4A 5A) 3.6 Effective team membership and team leadership. (LO: 3A 4A 5A)

***Note: LO refers to the Learning Outcome number(s) which link to the competency and the levels: N – Introductory, I – Intermediate and A - Advanced.* Refer to the Engineering Undergraduate Course Moodle site for further information on the Engineers Australia's Stage 1 Competency Standard for Professional Engineers and course level mapping informationhttps://moodle.cqu.edu.au/course/view.php?id=1511**

Alignment of Learning Outcomes, Assessment and Graduate Attributes

— N/A Level
• Introductory Level
• Intermediate Level
• Graduate Level
◦ Professional Level
◦ Advanced Level

Alignment of Assessment Tasks to Learning Outcomes

Assessment Tasks	Learning Outcomes				
	1	2	3	4	5
1 - Written Assessment - 20%	•			•	
2 - In-class Test(s) - 20%		•	•		
3 - Practical and Written Assessment - 20%		•	•		•
4 - Take Home Exam - 40%	•		•	•	

Alignment of Graduate Attributes to Learning Outcomes

Graduate Attributes	Learning Outcomes				
	1	2	3	4	5
1 - Communication	•	•	•		•
2 - Problem Solving			•	•	•
3 - Critical Thinking	•	•	•	•	
4 - Information Literacy					
5 - Team Work					•
6 - Information Technology Competence	•	•	•	•	
7 - Cross Cultural Competence					
8 - Ethical practice					•
9 - Social Innovation					
10 - Aboriginal and Torres Strait Islander Cultures					

Alignment of Assessment Tasks to Graduate Attributes

Assessment Tasks	Graduate Attributes									
	1	2	3	4	5	6	7	8	9	10
1 - Written Assessment - 20%	•	•	•			•				
2 - In-class Test(s) - 20%	•	•	•			•		•		

Assessment Tasks	Graduate Attributes									
	1	2	3	4	5	6	7	8	9	10
3 - Practical and Written Assessment - 20%	•	•	•		•	•		•		
4 - Take Home Exam - 40%	•	•	•			•				

Textbooks and Resources

Textbooks

ENAX12001

Prescribed

Power Electronics Devices, Circuits, and Applications
4th Edition (International) (2014)
Authors: Muhammad H. Rashid
Pearson Education Ltd.
Harlaw , England
ISBN: 978-0-273-76908-8
Binding: Hardcover

Additional Textbook Information
Textbooks can be accessed online at the CQUniversity Library website. If you prefer your own copy, you can purchase either paper or eBook versions at the CQUni Bookshop here: http://bookshop.cqu.edu.au (search on the Unit code)

IT Resources

You will need access to the following IT resources:

- CQUniversity Student Email
- Internet
- Unit Website (Moodle)
- Microsoft Excel (or equivalent)
- Multisim 14.0 Education Edition or later (National Instruments normally issues a student licence key to CQU - for students to install it on their private computers).

Referencing Style

All submissions for this unit must use the referencing style: Harvard (author-date)
For further information, see the Assessment Tasks.

Teaching Contacts

Piet Janse Van Rensburg Unit Coordinator
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Shaminda De Silva Unit Coordinator
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Schedule

Week 1 - 06 Mar 2023

Module/Topic	Chapter	Events and Submissions/Topic

• Introduction to Power Electronics • Power Diodes and LRC Circuits	Chapters 1 & 2	

Week 2 - 13 Mar 2023

Module/Topic	Chapter	Events and Submissions/Topic
Diode Rectifiers	Chapter 3	

Week 3 - 20 Mar 2023

Module/Topic	Chapter	Events and Submissions/Topic
Power Transistors	Chapter 4	

Week 4 - 27 Mar 2023

Module/Topic	Chapter	Events and Submissions/Topic
DC - DC Conversions	Chapter 5	

Week 5 - 03 Apr 2023

Module/Topic	Chapter	Events and Submissions/Topic
DC - AC Converters	Chapter 6	**Written Assessment** Due: Week 5 Thursday (6 Apr 2023) 11:00 pm AEST

Vacation Week - 10 Apr 2023

Module/Topic	Chapter	Events and Submissions/Topic

Week 6 - 17 Apr 2023

Module/Topic	Chapter	Events and Submissions/Topic
Multilevel Inverters	Chapter 8	

Week 7 - 24 Apr 2023

Module/Topic	Chapter	Events and Submissions/Topic
Resonant Pulse Inverters	Chapter 7	

Week 8 - 01 May 2023

Module/Topic	Chapter	Events and Submissions/Topic
• Thyristors • Controlled Rectifiers	Chapters 9 + 10	

Week 9 - 08 May 2023

Module/Topic	Chapter	Events and Submissions/Topic
AC Voltage Controllers	Chapter 11	

Week 10 - 15 May 2023

Module/Topic	Chapter	Events and Submissions/Topic
DC Drives	Chapter 14	

Week 11 - 22 May 2023

Module/Topic	Chapter	Events and Submissions/Topic
AC Drives	Chapter 15	**RES SCHOOL**: ALL STUDENTS @ MACKAY CAMPUS MON-WED **In-Class Test** Due: Week 11 Tuesday (23 May 2023) 11:00 am AEST

Week 12 - 29 May 2023

Module/Topic	Chapter	Events and Submissions/Topic
Introduction to Renewable Energy	Chapter 16	**Res School Laboratory Experiments** Due: Week 12 Thursday (1 June 2023) 11:00 pm AEST

Review/Exam Week - 05 Jun 2023

Module/Topic	Chapter	Events and Submissions/Topic

Exam Week - 12 Jun 2023

Module/Topic	Chapter	Events and Submissions/Topic

Assessment Tasks

1 Written Assessment

Assessment Type
Written Assessment

Task Description
This **individual** assignment together with feedback, helps to prepare you for the final End of Term Test.
The unit content from **Weeks 1 to 5** will be tested in Assignment 1. Questions will be largely analysis based.
Individual work is mandatory - this is a take-home test. None of your steps or solutions may be discussed or divulged to a fellow student.
Please refer to the CQU plagiarism policy - a **signed cover page declaring individual work** is required.
The assignment questions will be released on the unit website at least 2 weeks before the assignment is due to be submitted.
To prevent electronic plagiarism, **typed submissions are not acceptable**. Students should scan clear and legible hand written work for online submission as a **PDF** file.

Assessment Due Date
Week 5 Thursday (6 Apr 2023) 11:00 pm AEST
1) Plagiarism statement and 2) complete hand-written assignment scanned in together as a single .pdf file

Return Date to Students

It is endeavoured to provide feedback within 2 weeks of submission.

Weighting
20%

Minimum mark or grade
A minimum of 40% must be attained for the Written Assessment in order to pass the unit.

Assessment Criteria
Marks will be allocated for the followings:

1. Application of theoretical fundamentals.
2. Explanation of reasons to apply specific theory or method to solve a given problem where applicable.
3. Correct circuit diagrams/schematics and relevant input/output waveforms.
4. Correct mathematical working and correct answers.
5. All work and intermediate steps must be shown with justification of steps taken.
6. Assignments must be tidy and legible.

Referencing Style

- Harvard (author-date)

Submission
Online

Submission Instructions
1) Plagiarism statement and 2) complete hand-written assignment scanned in together as a single .pdf file

Learning Outcomes Assessed

- Explain the construction of power semiconductor devices, their principle of operation, and their suitability for various switching functions
- Analyse variable speed motor drives and controllers for different types of electric motors and evaluate their performances

Graduate Attributes

- Communication
- Problem Solving

- Critical Thinking
- Information Technology Competence

2 In-Class Test

Assessment Type
In-class Test(s)

Task Description
This **individual** analysis and design based test helps to prepare you for the end of term Online Test.
The unit content from **Weeks 5 to 9** will be tested in this Mid-Term test.
Individual work is mandatory. None of your steps or solutions may be discussed or divulged to a fellow student.
Please refer to the CQU plagiarism policy - a **signed cover page declaring individual work** is required.
The Test questions will be released on the unit website on the day.
To prevent electronic plagiarism, **typed submissions are not acceptable**. Students should scan clear and legible hand written work for online submission as a **PDF** file.

Assessment Due Date
Week 11 Tuesday (23 May 2023) 11:00 am AEST
To be conducted during Res School. Hand-written work should be submitted on paper.

Return Date to Students

It is endeavoured to provide feedback within 2 weeks of submission.

Weighting
20%

Minimum mark or grade
A minimum of 40% must be attained for the In-Class Test in order to pass the unit.

Assessment Criteria
Marks will be allocated for the followings:

1. Application of theoretical fundamentals.
2. Correct theory or method deployed to analyse and/or design power electronic circuitry where applicable.
3. Correct circuit diagrams/schematics and relevant input/output waveforms.
4. Correct mathematical working and correct answers.
5. All work and intermediate steps must be shown with justification of steps taken.
6. Assignments must be tidy and legible.

Referencing Style

- Harvard (author-date)

Submission
Online

Submission Instructions
1) Plagiarism statement, 2) complete hand-written assignment and 3) screen shot of Multisim circuit and results - all scanned in together as a single .pdf file

Learning Outcomes Assessed

- Compare and select power electronic components, converters, and drives for renewable energy integration and electric vehicles
- Analyse and model the operation of single-phase and three-phase power electronic circuits, including alternating current (AC) to direct current (DC), AC to AC, DC to DC, and DC to AC topologies

Graduate Attributes

- Communication
- Problem Solving
- Critical Thinking
- Information Technology Competence
- Ethical practice

3 Res School Laboratory Experiments

Assessment Type
Practical and Written Assessment

Task Description
Laboratory sessions are to be held during Residential School, **currently only on the MACKAY campus. Refer to the Handbook for dates.**
This assessment item consists of a series of laboratory experiments on plug-and-play power electronic circuits and drives.
Teams of 2 students should be formed, and **only ONE combined report** needs to be submitted by BOTH students.
Each student should submit a personal **signed cover page declaring the team work done**, specifying the other team member's name.
Each heading of the report should show the responsible team member's name in brackets.
Team reports must be **professional and typed**, including references.
Photographic evidence is required to prove that the various circuits were constructed and measurements were obtained - for this reason it is required that a team member's hand or fingers be included in all your photographs as a 'signature'.
Laboratories are compulsory and all students **must attend and pass** all laboratory assessments in order to pass the unit.
Detailed explanations of these experiments and how to carry them out will be posted on the unit website at the start of the term.

Assessment Due Date
Week 12 Thursday (1 June 2023) 11:00 pm AEST
Each student should submit a .PDF copy of their combined 2-person professional team report.

Return Date to Students

It is endeavoured to provide feedback within 2 weeks of submission.

Weighting
20%

Minimum mark or grade
A minimum of 50% must be attained for the Laboratory Experiments report in order to pass the unit.

Assessment Criteria
Laboratory Exercise Reports will be graded using the following criteria:

- Correct description of laboratory concepts and procedures;
- Correct calculations, analysis and thinking;
- Photographic evidence that circuits were constructed by the team;
- Correct measurements, answers and units;
- Photographic and other evidence that correct results / measurements were obtained by the team;
- Discussion and understanding of laboratory results;
- **Team reports** must be **professional and typed**, including references;
- All laboratory exercises must be attempted.

Referencing Style

- Harvard (author-date)

Submission
Online

Submission Instructions
Submit as a single .pdf file

Learning Outcomes Assessed

- Compare and select power electronic components, converters, and drives for renewable energy integration and electric vehicles
- Analyse and model the operation of single-phase and three-phase power electronic circuits, including alternating current (AC) to direct current (DC), AC to AC, DC to DC, and DC to AC topologies
- Work collaboratively and autonomously, and communicate professionally using power electronics terminology in presenting your solutions.

Graduate Attributes

- Communication
- Problem Solving
- Critical Thinking
- Team Work

- Information Technology Competence
- Ethical practice

4 End of Term Online Test

Assessment Type
Take Home Exam

Task Description
The End of Term Online Test will be released via Moodle at 09:00 am AEST on the day (timetable to be published towards the end of term).
This will be an 'open resource' exam including the internet, but you will be required to sign a declaration of individual work done.
No contact is allowed with fellow students or any person proficient in the field, i.e. neither virtual contact via the Moodle forums, nor using any communications technology to exchange information etc.
5 Hours will be allowed (due 14:00), but this includes scanning and uploading.
It is strongly advised to take one or more break during the 5-hour period and also to eat and drink something.
Late penalties will be deducted at 20% per hour (or proportional part).
Questions during the 5-hour period will be taken via email and where necessary, responses will be sent out to everyone via Q&A emails.

Assessment Due Date

To be written during the exam period. Please consult the unit Moodle page closer to the time.

Return Date to Students

CQU does not require that marked End of Term Online Test papers be made available to students. Grades will only be available after the confirmation of grades.

Weighting
40%

Minimum mark or grade
A minimum of 50% must be attained for the Take-Home Exam in order to pass the unit.

Assessment Criteria
Marks will be allocated for the followings:

1. Application of theoretical fundamentals.
2. Correct theory or method deployed to analyse and/or design power electronic circuitry where applicable.
3. Correct circuit diagrams/schematics and relevant input/output waveforms.
4. Correct mathematical working and correct answers.
5. All work and intermediate steps must be shown with justification of steps taken.
6. Work must be tidy and legible.

Referencing Style

- Harvard (author-date)

Submission
Online

Submission Instructions
Submit as a single pdf file.

Learning Outcomes Assessed

- Explain the construction of power semiconductor devices, their principle of operation, and their suitability for various switching functions
- Analyse and model the operation of single-phase and three-phase power electronic circuits, including alternating current (AC) to direct current (DC), AC to AC, DC to DC, and DC to AC topologies
- Analyse variable speed motor drives and controllers for different types of electric motors and evaluate their performances

Graduate Attributes

- Communication
- Problem Solving
- Critical Thinking

- Information Technology Competence

Academic Integrity Statement

As a CQUniversity student you are expected to act honestly in all aspects of your academic work.

Any assessable work undertaken or submitted for review or assessment must be your own work. Assessable work is any type of work you do to meet the assessment requirements in the unit, including draft work submitted for review and feedback and final work to be assessed.

When you use the ideas, words or data of others in your assessment, you must thoroughly and clearly acknowledge the source of this information by using the correct referencing style for your unit. Using others' work without proper acknowledgement may be considered a form of intellectual dishonesty.

Participating honestly, respectfully, responsibly, and fairly in your university study ensures the CQUniversity qualification you earn will be valued as a true indication of your individual academic achievement and will continue to receive the respect and recognition it deserves.

As a student, you are responsible for reading and following CQUniversity's policies, including the **Student Academic Integrity Policy and Procedure**. This policy sets out CQUniversity's expectations of you to act with integrity, examples of academic integrity breaches to avoid, the processes used to address alleged breaches of academic integrity, and potential penalties.

What is a breach of academic integrity?
A breach of academic integrity includes but is not limited to plagiarism, self-plagiarism, collusion, cheating, contract cheating, and academic misconduct. The Student Academic Integrity Policy and Procedure defines what these terms mean and gives examples.

Why is academic integrity important?
A breach of academic integrity may result in one or more penalties, including suspension or even expulsion from the University. It can also have negative implications for student visas and future enrolment at CQUniversity or elsewhere. Students who engage in contract cheating also risk being blackmailed by contract cheating services.

Where can I get assistance?
For academic advice and guidance, the Academic Learning Centre (ALC) can support you in becoming confident in completing assessments with integrity and of high standard.

What can you do to act with integrity?

Be Honest
If your assessment task is done by someone else, it would be dishonest of you to claim it as your own

Seek Help
If you are not sure about how to cite or reference in essays, reports etc, then seek help from your lecturer, the library or the Academic Learning Centre (ALC)

Produce Original Work
Originality comes from your ability to read widely, think critically, and apply your gained knowledge to address a question or problem