ENEE20004 *Digital Control Systems*
Term 1 - 2023

Profile information current as at 13/05/2024 01:03 am

General Information

Overview
This unit will enable you to develop an advanced understanding of digital control techniques applied in industrial control systems. The unit will introduce you to Z-transforms and Z Domain analysis of control systems through transformations. You will design and implement digital filters. You will learn discrete state space modeling and analysis of control systems. The unit will also equip you with knowledge of optimal control techniques such as linear quadratic and Kalman filtering. You will also learn about important digital control implementation techniques such as controller anti-windup and bumpless transfer. You will be required to successfully complete a digital control systems design team project. Online students will be required to attend a compulsory residential school in order to complete the laboratory experiments. Prior knowledge of the basic concepts of electrical circuit analysis, signals and linear systems, and control systems is assumed.

Details
Career Level: *Postgraduate*
Unit Level: *Level 9*
Credit Points: *12*
Student Contribution Band: *8*
Fraction of Full-Time Student Load: *0.25*

Pre-requisites or Co-requisites
There are no requisites for this unit.
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

- Melbourne
- Mixed Mode
- Rockhampton

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 12-credit Postgraduate unit at CQUniversity requires an overall time commitment of an average of 25 hours of study per week, making a total of 300 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. **Online Quiz(zes)**
Weighting: Pass/Fail
2. **Written Assessment**
Weighting: 10%
3. **Portfolio**
Weighting: 30%
4. **Practical Assessment**
Weighting: 20%
5. **Online Test**
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 SUTE

Feedback

Students expressed appreciation for the laboratory sessions, citing them as valuable opportunities to apply theoretical concepts learned in the unit.

Recommendation

This good practice should be maintained.

Feedback from SUTE

Feedback

Students valued the design project for its role in honing their skills in tackling real-world design challenges.

Recommendation

This good practice should be maintained.

Unit Learning Outcomes

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

1. Apply Z-transforms and Z Domain analysis of control systems through transformations
2. Design and implement various digital filters
3. Model, analyse stability and design control systems in discrete state space
4. Apply advanced optimal control techniques in industrial control systems
5. Design and implement digital control systems considering stakeholder requirements
6. Document and communicate professional engineering information, including computer-based simulations and drawings, risk assessments, and Work Health and Safety requirements using appropriate electrical engineering standards, terminology, and symbols
7. Scope, plan, manage and successfully complete engineering projects autonomously and in teams with responsible, ethical, and professional attitude regarding the role of engineers.

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

1.1 Comprehensive, theory-based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline. (LO: 1I 2I 3I)
1.4 Discernment of knowledge development and research directions within the engineering discipline. (LO: 1I 2I 3I 4I 5I)
2.3 Application of systematic engineering synthesis and design processes. (LO: 2I 3I 4I 5I)
3.2 Effective oral and written communication in professional and lay domains. (LO: 6I 7I)
3.3 Creative, innovative and pro-active demeanour. (LO: 2I 4I 5I)
3.5 Orderly management of self, and professional conduct. (LO: 7I)

Advanced

1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline. (LO: 1A 2I 3I 4A 5A)
1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline. (LO: 1A 2A 3N 4A 5A)
1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline. (LO: 2I 3N 4A 5A)
1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline. (LO: 3N 4A 5I)
2.1 Application of established engineering methods to complex engineering problem solving. (LO: 1N 2I 3I 4A 5A)
2.2 Fluent application of engineering techniques, tools and resources. (LO: 1N 2A 3I 4A 5A 6A)
2.4 Application of systematic approaches to the conduct and management of engineering projects. (LO: 2A 3I 4A 5I 6I 7A)
3.1 Ethical conduct and professional accountability. (LO: 7A)
3.4 Professional use and management of information. (LO: 2I 4I 5I 6A 7A)
3.6 Effective team membership and team leadership. (LO: 4I 5A 7A)

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 Postgraduate Units Moodle site for further information on the Engineers Australia's Stage 1 Competency Standard for Professional Engineers and course level mapping information
https://moodle.cqu.edu.au/course/view.php?id=11382

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	6	7
1 - Online Quiz(zes) - 0%	•						
2 - Written Assessment - 10%	•	•					
3 - Portfolio - 30%			•	•	•	•	•
4 - Practical Assessment - 20%					•	•	•
5 - Online Test - 40%		•	•	•			

Alignment of Graduate Attributes to Learning Outcomes

Graduate Attributes	Learning Outcomes						
	1	2	3	4	5	6	7
1 - Knowledge	∘	∘	∘	∘	∘	∘	∘
2 - Communication	∘	∘	∘	∘	∘	∘	∘
3 - Cognitive, technical and creative skills	∘	∘	∘	∘	∘		
4 - Research				∘	∘		
5 - Self-management						∘	∘
6 - Ethical and Professional Responsibility						∘	∘
7 - Leadership						∘	∘
8 - Aboriginal and Torres Strait Islander Cultures							

Textbooks and Resources

Textbooks

ENEE20004

Prescribed

Digital Control
Edition: 1 (2007)
Authors: Kannan Moudgalya
Wiley
Chichester , Sussex , England
ISBN: 978-0-470-03144-5
Binding: Paperback

Additional Textbook Information
Textbook can be accessed online at the CQUniversity Library website.

IT Resources

You will need access to the following IT resources:

- CQUniversity Student Email
- Internet
- Unit Website (Moodle)
- MATLAB and Simulink Suite Software

Referencing Style

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

Teaching Contacts

Kianoush Emami Unit Coordinator
k.emami@cqu.edu.au

Schedule

Week 1 - 06 Mar 2023

Module/Topic	Chapter	Events and Submissions/Topic
Modelling of Sampled Data Systems	Chapter 1 and Chapter 2	

Week 2 - 13 Mar 2023

Module/Topic	Chapter	Events and Submissions/Topic
Linear System	Chapter 3	

Week 3 - 20 Mar 2023

Module/Topic	Chapter	Events and Submissions/Topic
Z-Transform	Chapter 4	**Pre-test** Due: Week 3 Friday (24 Mar 2023) 11:45 pm AEST

Week 4 - 27 Mar 2023

Module/Topic	Chapter	Events and Submissions/Topic
Z-Transform	Chapter 4	

Week 5 - 03 Apr 2023

Module/Topic	Chapter	Events and Submissions/Topic
Frequency Domain Analysis	Chapter 5	

Vacation Week - 10 Apr 2023

Module/Topic	Chapter	Events and Submissions/Topic

Week 6 - 17 Apr 2023

Module/Topic	Chapter	Events and Submissions/Topic
Transfer Function Based Controller Design - Structures and Specifications	Chapter 7	

Week 7 - 24 Apr 2023

Module/Topic	Chapter	Events and Submissions/Topic
Proportional, Integral, Derivative Controllers	Chapter 8	**ASSIGNMENT** Due: Week 7 Friday (28 Apr 2023) 11:45 pm AEST

Week 8 - 01 May 2023

Module/Topic	Chapter	Events and Submissions/Topic
Pole Placement Controllers	Chapter 9 and Chapter 10	

Week 9 - 08 May 2023

Module/Topic	Chapter	Events and Submissions/Topic
Linear Quadratic Gaussian Control	Chapter 13	

Week 10 - 15 May 2023

Module/Topic	Chapter	Events and Submissions/Topic
State Space Techniques in Controller Design	Chapter 14	**Laboratory/Residential School and Lab Reports** Due: Week 10 Friday (19 May 2023) 11:45 pm AEST

Week 11 - 22 May 2023

Module/Topic	Chapter	Events and Submissions/Topic
State Space Techniques in Controller Design	Chapter 14	**Team Project** Due: Week 11 Friday (26 May 2023) 11:45 pm AEST

Week 12 - 29 May 2023

Module/Topic	Chapter	Events and Submissions/Topic

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
Exam		**Online Test** is scheduled during this week.

Assessment Tasks

1 Pre-test

Assessment Type
Online Quiz(zes)

Task Description
This assessment is designed to check the basic knowledge of the students about the control systems. Although there is no minimum pass mark to continue studying this unit, for the students who score lower marks in this assessment, additional support will be arranged to bring their fundamental

knowledge up to speed with the expectations of this unit. The content of this assessment will be based on the fundamental knowledge of control systems which students must have acquired during their undergraduate studies. The test date will be announced in advance and will be within Week 03 of the term.

Number of Quizzes

Frequency of Quizzes

Assessment Due Date
Week 3 Friday (24 Mar 2023) 11:45 pm AEST

Return Date to Students
Week 3 Friday (24 Mar 2023)
Students will know the test outcomes soon after completion.

Weighting
Pass/Fail

Assessment Criteria
There will be several questions in the test and you need to answer the questions within a limited time. You can attempt the test only once. There is no grade for this class test. The test result is only pass/fail.

Referencing Style

- Harvard (author-date)

Submission
Online

Learning Outcomes Assessed

- Apply Z-transforms and Z Domain analysis of control systems through transformations

2 ASSIGNMENT

Assessment Type
Written Assessment

Task Description
This assignment is designed to assess the learning outcomes of this unit. The assignment will have 4 - 8 problems associated with first five weeks of learning in this unit. The students will work individually and make individual submissions.

Assessment Due Date
Week 7 Friday (28 Apr 2023) 11:45 pm AEST
Make your individual submission to the link provided in Moodle site as a PDF/WORD file.

Return Date to Students
Week 9 Friday (12 May 2023)
Feedback will be provided through unit Moodle site.

Weighting
10%

Minimum mark or grade
50% of the marks allocated for this assignment

Assessment Criteria
Each question in this assignment will be assessed separately for the criterion accuracy and correct results and given a mark as specified in the assessment that will be published in the unit Moodle site. 10% of the total marks for this assignment are based on accuracy and correct results, including:

- Correct application of maths and arithmetic
- Answers clearly identified
- Correct results

In addition, the assignment as a whole will be assessed against the following criteria:
Evidence of correct procedures (50% of the total marks for the assignment)

- All necessary steps in analysis are present on correct order
- Clear presentation of mathematical and arithmetical working linking given details of the problem to the results
- obtained.

- Evidence of checking results (mathematical, graphical, logic-common sense)

Evidence of understanding of the topic (30% of the total marks for the assignment)

- Explanation of choices made in the analysis (why is procedure required, why this particular procedure)
- Interpretation of results, eg limitations, direction of vectors

Professional presentation (10% of the total marks for the assignment)

- The work (job) is clearly identified (problem, date, analyst)
- Clear statement of each problem and its details and requirements
- Logical layout of analysis
- Appropriate use of diagrams, clear diagrams
- Correct use of terminology, conventions
- Clear English in the explanation of procedure and interpretation of results.
- Referencing of authoritative sources of equations and data

Referencing Style

- Harvard (author-date)

Submission
Online

Submission Instructions
Make your individual submission to the link provided in Moodle site as a PDF/WORD file.

Learning Outcomes Assessed

- Apply Z-transforms and Z Domain analysis of control systems through transformations
- Design and implement various digital filters

3 Team Project

Assessment Type
Portfolio

Task Description
This compulsory assessment item is the project component of the unit. Students will carry out this in teams. Complete details of a digital control design project will be provided in unit Moodle site in the beginning of the term. Students will be carrying out the project in teams through out the term and submit a professionally done team report. The teams are supposed to attend a debriefing meeting in the mid-way of the project execution. Final reports that must be prepared as one submission per team are expected before the deadline specified below.

Assessment Due Date
Week 11 Friday (26 May 2023) 11:45 pm AEST
Make your team submission to the link provided in Moodle site as a PDF/WORD file.

Return Date to Students
Review/Exam Week Friday (9 June 2023)
Feedback will be provided through unit Moodle site.

Weighting
30%

Minimum mark or grade
50% of the marks allocated for this assignment

Assessment Criteria
Marks for the project will be given marks out of 100 based on the quality of each project activity; i.e. Debriefing meeting (10%), project report (80%), Peer assessment (10%). The marking schemes for each of those will be published in the Moodle site.

Referencing Style

- Harvard (author-date)

Submission
Online Group

Submission Instructions
Make your team submission to the link provided in Moodle site as a PDF/WORD file.

Learning Outcomes Assessed

- Model, analyse stability and design control systems in discrete state space
- Apply advanced optimal control techniques in industrial control systems
- Design and implement digital control systems considering stakeholder requirements
- Document and communicate professional engineering information, including computer-based simulations and drawings, risk assessments, and Work Health and Safety requirements using appropriate electrical engineering standards, terminology, and symbols
- Scope, plan, manage and successfully complete engineering projects autonomously and in teams with responsible, ethical, and professional attitude regarding the role of engineers.

4 Laboratory/Residential School and Lab Reports

Assessment Type
Practical Assessment

Task Description
The two day Residential School will be attended by both external students and internal students through a ZOOM link. See the handbook and Moodle site for the schedule. The laboratory sessions are conducted so that all students are simultaneously linked by Zoom videoconferencing with your relevant technical staff to support you through online during the laboratory session. Laboratories are a group activity, groups need to be formed early in the term and all group members need to participate in any preliminary task(s) prior to the conduction of the laboratory sessions, they must be actively involved during the conduction of the laboratory exercise and contribute to the generation of the laboratory report. Detailed laboratory report format information is provided on the Moodle site.

Assessment Due Date
Week 10 Friday (19 May 2023) 11:45 pm AEST
Make your team submission to the link provided in Moodle site as a PDF/WORD file.

Return Date to Students
Exam Week Friday (16 June 2023)
Feedback will be provided through unit Moodle site.

Weighting
20%

Minimum mark or grade
"50% of the marks allocated for this assignment

Assessment Criteria
Marking of the team reports will be done according to the following criteria.

- The accuracy and relevance of information
- Application of knowledge
- Language and grammar used in answering questions
- Proper referencing of sources of information
- Inclusion of all relevant Equations, images, data and tables, and the quality of presentation and layout.
- The marking scheme will be published in Moodle site together with Laboratory instruction sheets.

Referencing Style

- Harvard (author-date)

Submission
Online

Submission Instructions
Make your team submission to the link provided in Moodle site as a PDF/WORD file.

Learning Outcomes Assessed

- Design and implement digital control systems considering stakeholder requirements
- Document and communicate professional engineering information, including computer-based simulations and drawings, risk assessments, and Work Health and Safety requirements using appropriate electrical engineering standards, terminology, and symbols
- Scope, plan, manage and successfully complete engineering projects autonomously and in teams with responsible, ethical, and professional attitude regarding the role of engineers.

5 Online Test

Assessment Type
Online Test

Task Description
The Online Test is an individual assessment task conducted via the Unit Moodle website and during the University examination period. The questions will be available in Moodle during the Online Test period. The test will be open book and students can use any printed or electronic material as a reference. The questions answers should be handwritten and scanned after the test and uploaded by the given deadline. The test duration is three hours plus two additional hours for uploading and developing the answer sheet. The exam covers all contents of the unit from Week 1 to 12. Students are required to solve between 5 and 10 questions to demonstrate the theoretical knowledge they have learnt in this unit. Student must use blank A4 papers to write the answers and the final answer sheet must be submitted through the Online Test link in Moodle as a single pdf file.
In order to pass, students must score at least 50% of the allocated marks for the Online Test.

Assessment Due Date

Return Date to Students

Weighting
40%

Minimum mark or grade
In order to pass, students must score at least 50% of the allocated marks for this assessment.

Assessment Criteria
Each question in the Take Home Exam will be assessed separately for the criterion accuracy and correct results and given a mark from zero to 100 marks. 10% of the total mark of this assignment is based on accuracy and correct results, including:

- Correct application of maths and arithmetic
- Answers clearly identified
- Correct results

In addition, the assignment as a whole will be assessed against the following criteria:

- Evidence of correct procedures (50% of the total marks for the assignment)
- All necessary steps in analysis are present on correct order
- Clear presentation of mathematical and arithmetical working linking given details of the problem to the results
- obtained.
- Evidence of checking results (mathematical, graphical, logic-common sense)
- Evidence of understanding of the topic (30% of the total marks for the assignment)
- Explanation of choices made in the analysis (why is the procedure required, why is the particular procedure required)
- Interpretation of results, e.g., limitations, direction of vectors
- Professional presentation (10% of the total marks for the assignment)
- The work (job) is clearly identified (problem, date, analyst)
- Clear statement of each problem and its details and requirements
- Logical layout of analysis
- Appropriate use of diagrams, clear diagrams
- Correct use of terminology, conventions
- Clear English in the explanation of procedure and interpretation of results.
- Referencing of authoritative sources of equations and data

Referencing Style

- Harvard (author-date)

Submission
Online

Learning Outcomes Assessed

- Design and implement various digital filters
- Model, analyse stability and design control systems in discrete state space
- Apply advanced optimal control techniques in industrial control systems

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