



# ENEE20004 Digital Control Systems

## Term 2 - 2020

Profile information current as at 04/05/2024 01:28 am

All details in this unit profile for ENEE20004 have been officially approved by CQUniversity and represent a learning partnership between the University and you (our student). The information will not be changed unless absolutely necessary and any change will be clearly indicated by an approved correction included in the profile.

## 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 2 - 2020

- Melbourne
- Perth
- 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. **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 Unit Evaluation

**Feedback**

Students appreciated the design project which helped them to gain skill in designing real world problems.

**Recommendation**

This good practice will be continued.

#### Feedback from Unit Evaluation

**Feedback**

Students found the labs helpful in practicing the implementation of theories they learnt in this unit

**Recommendation**

This good practice will be continued.

#### Feedback from Unit Coordinator

**Feedback**

The lab hardware must be upgraded in order to be able to work with the newer version of MATLAB.

**Recommendation**

In the future offering, the upgraded lab hardware will be used so the hardware will be compatible with MATLAB 2020.

#### Feedback from Unit Coordinator

**Feedback**

The lab manuals need to be revisited so the lab procedures are more clear to students.

**Recommendation**

In future offerings, the contents of the lab manuals will be revised in order to make the contents more clear to students.

## 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.

Learning outcomes will be linked to Engineers Australia stage 1 competency standards for Professional Engineers.

## 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 - Take Home Exam - 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 |                   |   |   |   |   |   |   |

### Alignment of Assessment Tasks to Graduate Attributes

| Assessment Tasks               | Graduate Attributes |   |   |   |   |   |   |   |
|--------------------------------|---------------------|---|---|---|---|---|---|---|
|                                | 1                   | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 - Online Quiz(zes) - 0%      | ○                   |   |   |   |   |   |   |   |
| 2 - Written Assessment - 10%   | ○                   | ○ | ○ |   | ○ |   |   |   |
| 3 - Portfolio - 30%            | ○                   | ○ | ○ | ○ | ○ | ○ | ○ |   |
| 4 - Practical Assessment - 20% | ○                   | ○ | ○ |   | ○ | ○ | ○ |   |
| 5 - Take Home Exam - 40%       | ○                   | ○ | ○ |   | ○ | ○ |   |   |

## 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

### 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

**Mohammad Khyam** Unit Coordinator

[m.khyam@cqu.edu.au](mailto:m.khyam@cqu.edu.au)

## Schedule

### Week 1 - 13 Jul 2020

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

### Week 2 - 20 Jul 2020

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

### Week 3 - 27 Jul 2020

| Module/Topic | Chapter   | Events and Submissions/Topic                                    |
|--------------|-----------|---|
| Z-Transform  | Chapter 4 | <b>Pre-test</b> Due: Week 3 Friday (31 July 2020) 11:45 pm AEST |

### Week 4 - 03 Aug 2020

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

### Week 5 - 10 Aug 2020

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

| <b>Vacation Week - 17 Aug 2020</b>  |                          |   |
|---|--------------------------|---|
| <b>Module/Topic</b>   | <b>Chapter</b>           | <b>Events and Submissions/Topic</b>   |
| <b>Week 6 - 24 Aug 2020</b>   |                          |   |
| <b>Module/Topic</b>   | <b>Chapter</b>           | <b>Events and Submissions/Topic</b>   |
| Transfer Function Based Controller Design - Structures and Specifications | Chapter 7                |   |
| <b>Week 7 - 31 Aug 2020</b>   |                          |   |
| <b>Module/Topic</b>   | <b>Chapter</b>           | <b>Events and Submissions/Topic</b>   |
| Proportional, Integral, Derivative Controllers                            | Chapter 8                | <b>ASSIGNMENT 1</b> Due: Week 7 Friday (4 Sept 2020) 11:45 pm AEST                                    |
| <b>Week 8 - 07 Sep 2020</b>   |                          |   |
| <b>Module/Topic</b>   | <b>Chapter</b>           | <b>Events and Submissions/Topic</b>   |
| Pole Placement Controllers  | Chapter 9 and Chapter 10 |   |
| <b>Week 9 - 14 Sep 2020</b>   |                          |   |
| <b>Module/Topic</b>   | <b>Chapter</b>           | <b>Events and Submissions/Topic</b>   |
| Linear Quadratic Gaussian Control   | Chapter 13               |   |
| <b>Week 10 - 21 Sep 2020</b>  |                          |   |
| <b>Module/Topic</b>   | <b>Chapter</b>           | <b>Events and Submissions/Topic</b>   |
| State Space Techniques in Controller Design                               | Chapter 14               | <b>Laboratory/Residential School and Lab Reports</b> Due: Week 10 Friday (25 Sept 2020) 11:45 pm AEST |
| <b>Week 11 - 28 Sep 2020</b>  |                          |   |
| <b>Module/Topic</b>   | <b>Chapter</b>           | <b>Events and Submissions/Topic</b>   |
| State Space Techniques in Controller Design                               | Chapter 14               | <b>Team Project</b> Due: Week 11 Friday (2 Oct 2020) 11:45 pm AEST                                    |
| <b>Week 12 - 05 Oct 2020</b>  |                          |   |
| <b>Module/Topic</b>   | <b>Chapter</b>           | <b>Events and Submissions/Topic</b>   |
|   |                          |   |
| <b>Review/Exam Week - 12 Oct 2020</b>                                     |                          |   |
| <b>Module/Topic</b>   | <b>Chapter</b>           | <b>Events and Submissions/Topic</b>   |
|   |                          |   |
| <b>Exam Week - 19 Oct 2020</b>  |                          |   |
| <b>Module/Topic</b>   | <b>Chapter</b>           | <b>Events and Submissions/Topic</b>   |
| Exam  |                          | <b>Exam</b> Due: During the exam 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 (31 July 2020) 11:45 pm AEST

**Return Date to Students**

Week 3 Friday (31 July 2020)

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

**Graduate Attributes**

- Knowledge

## 2 ASSIGNMENT 1

**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 (4 Sept 2020) 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 (18 Sept 2020)

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

### Graduate Attributes

- Knowledge
- Communication
- Cognitive, technical and creative skills
- Self-management

## 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 throughout 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 (2 Oct 2020) 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 (16 Oct 2020)

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

**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.

**Graduate Attributes**

- Knowledge
- Communication
- Cognitive, technical and creative skills
- Research
- Self-management
- Ethical and Professional Responsibility
- Leadership

## 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 (25 Sept 2020) 11:45 pm AEST

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

**Return Date to Students**

Week 12 Friday (9 Oct 2020)

Feedback will be provided through unit Moodle site.

**Weighting**

20%

**Minimum mark or grade**

50% of the marks allocated for this unit

**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.

### **Graduate Attributes**

- Knowledge
- Communication
- Cognitive, technical and creative skills
- Self-management
- Ethical and Professional Responsibility
- Leadership

## **5 Take Home Exam**

### **Assessment Type**

Take Home Exam

### **Task Description**

This take home examination will be monitored through a ZOOM session and students will have to provide written answers to some questions.

1. Examination will be time scheduled and will take place for everyone at the same time.
2. Each student stays home with a device (preferably a laptop) essentially having a camera through which we can watch the student in a ZOOM session during the examination (please make sure you have a device with these requirements functioning).
3. That ZOOM link needs to be open throughout the exam.
4. The examination paper will be loaded to the Moodle so that students only can access it during examination period.
5. The student uses blank A4 papers (single side) to write answers.
6. At the end of the examination, he/she first takes photos of all written pages and email invigilator.
7. Later he/she scan the pages and upload to Moodle within a specified time at the end of examination.
8. Examination date and time will be within the standard examination period for Term 2-2020.

### **Assessment Due Date**

During the exam week.

### **Return Date to Students**

### **Weighting**

40%

### **Minimum mark or grade**

50% of the marks allocated for this assignment

### **Assessment Criteria**

No Assessment Criteria

### **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**

- 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

## Graduate Attributes

- Knowledge
- Communication
- Cognitive, technical and creative skills
- Self-management
- Ethical and Professional Responsibility

## 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