ENEX13004 *Robotics and Autonomous Systems*
Term 1 - 2026

Profile information current as at 21/04/2026 08:08 pm

General Information

Overview
This unit will introduce you to robotics and artificial intelligence in autonomous systems. You will learn the principles of robotic manipulators, mobile robots, robotic vision systems, forward kinematics, inverse kinematics of robotic manipulators, and programming. You will program industrial and mobile robots using Python programming language to model robotic systems mathematically, plan their path trajectories and predict and avoid collision with objects in the surrounding environment by fusing information from various sensors. The Robotic Operating System (ROS) is used with Gazebo robotic simulator to build and test various robotic applications. You are introduced to Linux operating system and will learn different ROS commands to test and troubleshoot real-world robotic systems. In addition, you will complete laboratory activities with real robots to strengthen your knowledge before completing a project in Gazebo simulated environment to solve a real-world problem. This unit supports the UN sustainable development goal 9-industry, innovation and infrastructure by discussing sustainable industrialisation using robotic applications.

Details
Career Level: *Undergraduate*
Unit Level: *Level 3*
Credit Points: *6*
Student Contribution Band: *8*
Fraction of Full-Time Student Load: *0.125*

Pre-requisites or Co-requisites
Prerequisites: ENEM12010 Engineering Dynamics AND MATH11219 Applied Calculus.
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 - 2026
- Mackay
- 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).

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. Written Assessment
Weighting: 20%
3. Practical and Written Assessment
Weighting: 20%
4. Project (applied)
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 Data

Feedback
The response rate to the student unit evaluation survey is low.

Recommendation
Students should be encouraged to participate in SUTE surveys through announcements and in-class reminders.

Unit Learning Outcomes

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

1. Analyse robotic systems and manipulators by applying knowledge of kinematics and coordinate system transformation
2. Develop mathematical models to simulate robotic systems using the Robotic Operating System (ROS)
3. Program industrial robots using industry-standard programming software
4. Develop control systems for robotics sub-systems by extracting meaningful information from sensors using artificial intelligence techniques
5. Develop complete robotic solutions to solve real-life problems by combining theoretical knowledge and practical skills
6. Work individually and collaboratively in teams, communicate professionally by using robotic engineering terminology, symbols, and diagrams.

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 1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline. (LO: 5I) 2.4 Application of systematic approaches to the conduct and management of engineering projects. (LO: 5I) 3.1 Ethical conduct and professional accountability. (LO: 6I) 3.2 Effective oral and written communication in professional and lay domains. (LO: 6I) 3.3 Creative, innovative and pro-active demeanour. (LO: 5I) 3.4 Professional use and management of information. (LO: 5I) 3.6 Effective team membership and team leadership. (LO: 6I) Advanced 1.1 Comprehensive, theory-based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline. (LO: 1A) 1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline. (LO: 1A 2A) 1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline. (LO: 3A 4A 5A) 1.4 Discernment of knowledge development and research directions within the engineering discipline. (LO: 5A) 2.1 Application of established engineering methods to complex engineering problem solving. (LO: 1A 2A 3A 4I 5A) 2.2 Fluent application of engineering techniques, tools and resources. (LO: 2A 3A 4A 5A) 2.3 Application of systematic engineering synthesis and design processes. (LO: 3I 4I 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 information https://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	6
1 - Written Assessment - 20%	•	•				
2 - Written Assessment - 20%	•	•				
3 - Practical and Written Assessment - 20%			•	•		•
4 - Project (applied) - 40%			•	•	•	•

Alignment of Graduate Attributes to Learning Outcomes

Graduate Attributes	Learning Outcomes					
	1	2	3	4	5	6
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 - First Nations Knowledges						
11 - Aboriginal and Torres Strait Islander Cultures						

Textbooks and Resources

Textbooks

There are no required textbooks.

IT Resources

You will need access to the following IT resources:

- CQUniversity Student Email
- Internet
- Unit Website (Moodle)
- Microsoft Teams - camera and microphone
- Virtualbox (Version 7 or later)
- A computer with suitable hardware resources (8GB Memory, Intel core i5 and above CPU, Dedicated GPU is desired) and Windows(10 or later) with admin rights to install Virtual Box 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

Lasi Piyathilaka Unit Coordinator
l.piyathilaka@cqu.edu.au

Schedule

Week 1 - 09 Mar 2026

Module/Topic	Chapter	Events and Submissions/Topic
Introduction • Introduction to Robotics • Robotic Software Installation • Linux Basics • Introduction to Robotic Operating System (ROS)	• Moodle Week 1 Learning Resources	

Week 2 - 16 Mar 2026

Module/Topic	Chapter	Events and Submissions/Topic
Representing Position and Orientation • Robot Spatial Descriptions and Transformations • Robotic Simulation Environments • ROS Programming with Python • Robotic Coordinate Transformation	• Moodle Week 2 Learning Resources	

Week 3 - 23 Mar 2026

Module/Topic	Chapter	Events and Submissions/Topic
Robotic Manipulators • Robotic Manipulator Modeling • Forward Kinematics • Robotic Arm Simulation	• Moodle Week 3 Learning Resources	

Week 4 - 30 Mar 2026

Module/Topic	Chapter	Events and Submissions/Topic

Motion Planning • Inverse Kinematics (IK) of Robotic Manipulators • Programming with Inverse Kinematic Solvers • Manipulator Motion Planning	• Moodle Week 4 Learning Resources	

Week 5 - 06 Apr 2026

Module/Topic	Chapter	Events and Submissions/Topic
• Machine-learning and visual object recognition	• Moodle Week 5 Learning Resources	Written and Coding Assessment 1 Due: Week 5 Monday (6 Apr 2026) 11:45 pm AEST

Week 6 - 13 Apr 2026

Module/Topic	Chapter	Events and Submissions/Topic
Mobile Robots • Modelling • Kinematics	• Moodle Week 6 Learning Resources	

Vacation Week - 20 Apr 2026

Module/Topic	Chapter	Events and Submissions/Topic

Week 7 - 27 Apr 2026

Module/Topic	Chapter	Events and Submissions/Topic
Robotic Perception • Robotic Sensors • Image Processing Techniques	• Moodle Week 7 Learning Resources	

Week 8 - 04 May 2026

Module/Topic	Chapter	Events and Submissions/Topic
Robotic Localisation • Map building • Localisation algorithms	• Moodle Week 8 Learning Resources	Written and Coding Assessment 2 Due: Week 8 Monday (4 May 2026) 11:45 pm AEST

Week 9 - 11 May 2026

Module/Topic	Chapter	Events and Submissions/Topic
Robotic Navigation • Path planning algorithms • Global Planner • Local Planner	• Moodle Week 9 Learning Resources	

Week 10 - 18 May 2026

Module/Topic	Chapter	Events and Submissions/Topic
		Residential School
Lab exercises		Practical and Written assessment - Labs Due: Week 10 Thursday (21 May 2026) 11:45 pm AEST

Week 11 - 25 May 2026

Module/Topic	Chapter	Events and Submissions/Topic
Project Help		

Week 12 - 01 Jun 2026

Module/Topic	Chapter	Events and Submissions/Topic
		Project Demonstration.
Project demonstrations		Robotic Project Due: Week 12 Thursday (4 June 2026) 11:45 pm AEST

Exam Week - 08 Jun 2026

Module/Topic	Chapter	Events and Submissions/Topic

Vacation/Exam Week - 15 Jun 2026

Module/Topic	Chapter	Events and Submissions/Topic

Term Specific Information

This unit includes a compulsory residential school conducted at the Mackay Ooralea and Rockhampton campuses.

Assessment Tasks

1 Written and Coding Assessment 1

Assessment Type
Written Assessment

Task Description
This assessment will consist of problems that require you to implement software using the Robotic Operating System (ROS) and the Python programming language. You are expected to learn the basics of the Python programming language and the ROS framework during the first two weeks of the course. Interactive software tutorials will be provided using ROS to help you gain hands-on experience, and the assessment items will be extensions of these tutorials. Therefore, you are required to complete the interactive tutorials before attempting the assessment items.
The assessment questions and marking criteria will be available on the Moodle course page. This assessment will test your understanding of coordinate system transformations, mathematical modelling of robotic manipulators, and trajectory generation. You are required to demonstrate your understanding by developing robotic models in ROS simulation environments and generating trajectories using the Python programming language.
Your final submission must include the software codes, the simulation outputs, video demonstrations, and a report.
Minimum mark requirement: You must achieve at least 30% for this assessment.
This assessment uses the University's 72-hour grace period after the deadline; no late penalty applies within that window.

AI ASSESSMENT SCALE - AI COLLABORATION
You may use AI to assist with specific tasks such as drafting text, refining, and evaluating your work. You must critically evaluate and modify any AI-generated content you use.

Assessment Due Date
Week 5 Monday (6 Apr 2026) 11:45 pm AEST

Return Date to Students

Marked work will be returned two weeks from submission.

Weighting
20%

Minimum mark or grade
30%

Assessment Criteria
To obtain full marks for this assessment, you must satisfy the following requirements:

1. Your computer code must be appropriately structured, properly commented, and demonstrate relevant coding practices.
2. The mathematical models you develop must be accurate and produce logically justified results.
3. Your computer code must execute without compilation or runtime errors.
4. The software output must be consistent with the explanations provided in the report and the simulation results included in the submission.
5. All workings and assumptions must be clearly presented.

Referencing Style

- Harvard (author-date)

Submission
Online

Submission Instructions
All software codes, simulation outputs, the report, and video demonstrations must be uploaded to Moodle.

Learning Outcomes Assessed
- Analyse robotic systems and manipulators by applying knowledge of kinematics and coordinate system transformation
- Develop mathematical models to simulate robotic systems using the Robotic Operating System (ROS)

2 Written and Coding Assessment 2

Assessment Type
Written Assessment

Task Description
For this assessment, you will be tested on your understanding of inverse kinematics and the application of machine-learning models for object detection. You will also be required to develop mathematical models for multi-link robotic manipulators and create simulation models using the Robotic Operating System (ROS) framework. In addition, you will be expected to create an image dataset and train the YOLO deep learning network for object detection.
To complete this assignment, you will need a strong understanding of advanced ROS concepts. Weekly interactive tutorials will cover the required topics and provide relevant code samples to support your learning. You must also prepare a report that includes code outputs, explanations, and simulation results.
Your final submission must include the software codes, the simulation outputs, video demonstrations, and a report.
Minimum mark requirement: You must achieve at least 50% for this assessment.
This assessment uses the University's 72-hour grace period after the deadline; no late penalty applies within that window.

AI ASSESSMENT SCALE - AI COLLABORATION
You may use AI to assist with specific tasks such as drafting text, refining, and evaluating your work. You must critically evaluate and modify any AI-generated content you use.

Assessment Due Date
Week 8 Monday (4 May 2026) 11:45 pm AEST

Return Date to Students

Marked work will be returned two weeks from submission.

Weighting
20%

Minimum mark or grade
50%

Assessment Criteria
To obtain full marks for this assessment, you must satisfy the following requirements:
1. Your computer code must be appropriately structured, properly commented, and demonstrate relevant coding practices.
2. The mathematical models you develop must be accurate and produce logically justified results.
3. Your computer code must execute without compilation or runtime errors.
4. The software output must be consistent with the explanations provided in the report and the simulation results included in the submission.
5. All workings and assumptions must be clearly presented.

Referencing Style
- Harvard (author-date)

Submission
Online

Submission Instructions
All software codes, simulation outputs, the report, and video demonstrations must be uploaded to Moodle.

Learning Outcomes Assessed
- Analyse robotic systems and manipulators by applying knowledge of kinematics and coordinate system transformation
- Develop mathematical models to simulate robotic systems using the Robotic Operating System (ROS)

3 Practical and Written assessment - Labs

Assessment Type
Practical and Written Assessment

Task Description
This assessment consists of computer laboratory sessions and practical activities with robots and is divided into four laboratory assessments (Labs 1 to 4). You are required to use the specified software and simulation environment to complete each lab. Most labs can be completed within the simulation environment; however, you must attend the mandatory laboratory sessions that involve direct robot interaction.
Details of these labs and practical activities will be available on the unit Moodle website. The laboratory and practical components are compulsory, and you must pass them in order to pass the unit. All students are required to complete the labs during the compulsory residential school. Laboratory reports must be submitted individually, and team reports will not be accepted.
Minimum mark requirement: You must achieve at least 50% for this assessment.
This assessment uses the 72-hour grace period for submissions; however, attendance at scheduled in-person lab sessions is mandatory and cannot be deferred

AI ASSESSMENT SCALE - AI COLLABORATION
You may use AI to assist with specific tasks such as drafting text, refining, and evaluating your work. You must critically evaluate and modify any AI-generated content you use.

Assessment Due Date
Week 10 Thursday (21 May 2026) 11:45 pm AEST

Return Date to Students

Marked work will be returned two weeks from submission.

Weighting
20%

Minimum mark or grade
You must achieve ≥50% combined across Labs 1–4 and pass all mandatory in-person labs to pass the unit.

Assessment Criteria
To obtain full marks for this assessment, you must satisfy the following requirements:

1. You must provide correct answers, including relevant plots and figures where appropriate.
2. Your code must be readable, well-structured, neat, and clearly organised.
3. You must properly comment and appropriately format your computer code.
4. Your computer code must run without compilation or execution errors.
5. Your software output must be consistent with the explanations in your report and the simulation results included in your submission.
6. You must clearly show all workings and assumptions.

Referencing Style
- Harvard (author-date)

Submission
Online

Submission Instructions
All software codes, simulation outputs, the report, and video demonstrations must be uploaded to Moodle.

Learning Outcomes Assessed
- Program industrial robots using industry-standard programming software
- Develop control systems for robotics sub-systems by extracting meaningful information from sensors using artificial intelligence techniques
- Work individually and collaboratively in teams, communicate professionally by using robotic engineering terminology, symbols, and diagrams.

4 Robotic Project

Assessment Type
Project (applied)

Task Description
This is a project-based assignment that addresses a real-world challenge, where the project and its report form the primary assessment components. You are permitted to work in a group of two to three students. The project is task-

based and requires your group to program robotic platforms to complete specified tasks, with marks awarded based on the successful completion of each task.
You are expected to commence your group project work in Week 5, with the final demonstration scheduled for Week 12. Each student must submit an individual report outlining their specific contributions; a single report per group will not be accepted. The project output must be demonstrated within a simulation environment, and the final codebase must be submitted to the assigned code repository. Peer evaluation will also be conducted to assess individual contributions within each group.
Minimum mark requirement: You must achieve at least 50% for this assessment.
This assessment uses the University's 72-hour grace period after the deadline; no late penalty applies within that window.

AI ASSESSMENT SCALE - AI COLLABORATION
You may use AI to assist with specific tasks such as drafting text, refining, and evaluating your work. You must critically evaluate and modify any AI-generated content you use.

Assessment Due Date
Week 12 Thursday (4 June 2026) 11:45 pm AEST

Return Date to Students

Marked work will be returned two weeks from submission.

Weighting
40%

Minimum mark or grade
50%

Assessment Criteria
Marks for this project will be awarded based on two main components: Project Demonstration and Project Report.

1. Project Demonstration

You will be assessed on:
- Successful completion of each assigned task
- Clear explanation of how each task was solved
- Your ability to answer questions from the audience and the Unit Coordinator

2. Project Report

You will be assessed on:
- A well-structured report with appropriate formatting
- Clear and detailed explanation of the code and implementation
- Inclusion of the project timeline and progress
- Critical analysis of the project's success and challenges
- Reflection on your learning outcomes and areas for improvement

To achieve high marks, you must demonstrate strong practical performance during the project demonstration and provide clear technical understanding and reflection in your written report.

Referencing Style
- Harvard (author-date)

Submission
Online

Submission Instructions
Project demonstration will be conducted online via Zoom. All software codes, simulation outputs, the report, and video demonstrations must be uploaded to Moodle.

Learning Outcomes Assessed
- Program industrial robots using industry-standard programming software
- Develop control systems for robotics sub-systems by extracting meaningful information from sensors using artificial intelligence techniques
- Develop complete robotic solutions to solve real-life problems by combining theoretical knowledge and practical skills
- Work individually and collaboratively in teams, communicate professionally by using robotic engineering terminology, symbols, and diagrams.

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