ENEX13004 *Advanced Dynamics and Robotics*
Term 1 - 2022

Profile information current as at 14/12/2025 04:11 pm

General Information

Overview

This unit will introduce you to advanced dynamics and robotics. You will learn the principle of operation of robotic manipulators, mobile robots, robotic vision systems, forward kinematics and inverse kinematics of robotic manipulators, robot dynamics and control, and programming robots using industry standard software. You will be able to program industrial robots, mobile robots, and humanoid robots for a given task. You will also be able to mathematically model robotic manipulators, plan their link and joint trajectories, predict and avoid collision with objects in the surrounding environment by fusing information from various sensors attached to the robotic device. In this unit, you must complete compulsory practical activities. Refer to the Engineering Undergraduate Course Moodle site for proposed dates.

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 MATH12222 Advanced Mathematical Applications AND ENEE12016 Signals and Systems
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 - 2022

- 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. **Portfolio**
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 Formal Unit Evaluation Survey

Feedback
The time provided to complete the portfolio project is not enough.

Recommendation
Encourage students to start the portfolio project early by distributing the assessment tasks with multiple soft deadlines.

Feedback from Formal Unit Evaluation Survey

Feedback
The support for the online students during the portfolio team project needs to be improved.

Recommendation
Conduct a separate help session for the online students using Microsoft Teams and Zoom.

Feedback from Self-reflection

Feedback
Lack of equal contribution to the portfolio project by some team members.

Recommendation
Distribute the portfolio project tasks equally among team members, and add a peer assessment task to the portfolio project.

Unit Learning Outcomes

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

1. Analyse robotic systems including robotic manipulators by using the knowledge of kinematics, dynamics, and coordinate system transformation
2. Develop mathematical models to simulate robotic systems using Robotic Operating System (ROS)
3. Program industrial robots using industry-standard programming software
4. Develop control systems for robotics sub-systems by extracting information from sensors
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 - Portfolio - 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 - 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 - Written Assessment - 20%		•	•			•				
3 - Practical and Written Assessment - 20%	•	•	•		•	•		•		
4 - Portfolio - 40%	•	•	•		•	•		•		

Textbooks and Resources

Textbooks

ENEX13004

Prescribed

Robotics, Vision and Control
(2017)
Authors: Peter Corke
Springer-Verlag Berlin Heidelberg
ISBN: 978-3-642-20144-8
Binding: eBook

Additional Textbook Information
The ebook can be accessed through the CQUniversity Library Website and students are not required to purchase it.

IT Resources

You will need access to the following IT resources:

- CQUniversity Student Email
- Internet
- Unit Website (Moodle)
- A computer with suitable hardware resources (8GB Memory, Intel core i5 and above CPU, Dedicated GPU is desired) and Windows(7 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 - 07 Mar 2022

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

Week 2 - 14 Mar 2022

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	• Chapter 2 (Robotic Vision and Control by Peter Corke) • Moodle Week 2 Learning Resources	

Week 3 - 21 Mar 2022

Module/Topic	Chapter	Events and Submissions/Topic
Robotic Manipulators • Robotic Manipulator Modeling • Forward Kinematics • Robotic Arm Simulation	• Chapter 7.1 (Robotic Vision and Control by Peter Corke) • Moodle Week 3 Learning Resources	Team formation for the robotic competition

Week 4 - 28 Mar 2022

Module/Topic	Chapter	Events and Submissions/Topic
Motion Planning • Inverse Kinematics (IK) of Robotic Manipulators • Programming with Inverse Kinematic Solvers • Manipulator Motion Planning	• Chapter 7.2 (Robotic Vision and Control by Peter Corke) • Moodle Week 4 Learning Resources	**Written and Coding Assessment 1** Due: Week 4 Friday (1 Apr 2022) 12:00 am AEST

Week 5 - 04 Apr 2022

Module/Topic	Chapter	Events and Submissions/Topic
Robotic Dynamics • Rigid Body Dynamics • Dynamic Modelling • Feedback Control	• Chapter 9 (Robotic Vision and Control by Peter Corke) • Moodle Week 5 Learning Resources	

Vacation Week - 11 Apr 2022

Module/Topic	Chapter	Events and Submissions/Topic

Week 6 - 18 Apr 2022

Module/Topic	Chapter	Events and Submissions/Topic
Mobile Robots • Modelling • Kinematics	• Chapter 4 (Robotic Vision and Control by Peter Corke) • Moodle Week 6 Learning Resources	

Week 7 - 25 Apr 2022

Module/Topic	Chapter	Events and Submissions/Topic
Robotic Perception • Robotic Sensors • Image processing	• Chapter 10-12 (Robotic Vision and Control by Peter Corke) • Moodle Week 7 Learning Resources	**Written and Coding Assessment 2** Due: Week 7 Friday (29 Apr 2022) 12:00 am AEST

Week 8 - 02 May 2022

Module/Topic	Chapter	Events and Submissions/Topic
Robotic Localisation • Map building • Localisation algorithms	• Chapter 6 (Robotic Vision and Control by Peter Corke) • Moodle Week 8 Learning Resources	Submit project methodology and code flowcharts with the role of each team member

Week 9 - 09 May 2022

Module/Topic	Chapter	Events and Submissions/Topic
Robotic Navigation • Path planning algorithms • Global Planner • Local Planner	• Chapter 5 (Robotic Vision and Control by Peter Corke) • Moodle Week 9 Learning Resources	

Week 10 - 16 May 2022

Module/Topic	Chapter	Events and Submissions/Topic
Lab exercises		Residential School **Practical and Written assessment - Labs** Due: Week 10 Friday (20 May 2022) 11:45 pm AEST

Week 11 - 23 May 2022

Module/Topic	Chapter	Events and Submissions/Topic
Project Help		

Week 12 - 30 May 2022

Module/Topic	Chapter	Events and Submissions/Topic
Robotic Competion		Robotic Competition and Project Demonstration **Portfolio** Due: Week 12 Friday (3 June 2022) 3:00 pm AEST

Review/Exam Week - 06 Jun 2022

Module/Topic	Chapter	Events and Submissions/Topic

Exam Week - 13 Jun 2022

Module/Topic	Chapter	Events and Submissions/Topic

Term Specific Information

The compulsory residential school will be held at Mackay campus

Assessment Tasks

1 Written and Coding Assessment 1

Assessment Type
Written Assessment

Task Description
This assessment will consist of problems with software implementation using the Robotic Operating System (ROS) and Python programming language. The students are expected to learn the basics of Python programming language and ROS framework in the first 2 weeks of the course. Interactive software tutorials will be provided using ROS to get hands-on experience, and the assessment items will be extensions of tutorials. Therefore, the students are required to complete interactive tutorials before attempting the assessment items. The assessment questions and criteria will be available on the Moodle course page. This assessment will test the students' understanding of the coordinate system transformation, mathematical modelling of robotic manipulators and trajectory generation. The students are required to showcase their understanding by developing robotic models in ROS simulation environments and trajectory generation using the Python programming language. The final submission must include the scripts, the simulation outputs and the report. The report must include explanations for code outputs and simulation results.

Assessment Due Date
Week 4 Friday (1 Apr 2022) 12:00 am AEST

Return Date to Students

Two weeks from submission

Weighting
20%

Minimum mark or grade
30%

Assessment Criteria
The following assessment requirements need to be fulfilled to obtain the full marks for this assessment.
1. Computer codes are properly commented and relevant coding practices are used
2. Developed mathematical models are accurate and output expected results
3. Computer code should not have any compilation errors
4. Software code output should match with the report and simulation results included in the submission
5. All working and assumptions must be shown

Referencing Style

- Harvard (author-date)

Submission
Online

Submission Instructions
One zip folder with the report, codes and simulation outputs. The software code needs to uploaded to the code repository.

Learning Outcomes Assessed

- Analyse robotic systems including robotic manipulators by using the knowledge of kinematics, dynamics, and coordinate system transformation
- Develop mathematical models to simulate robotic systems using Robotic Operating System (ROS)

Graduate Attributes

- Problem Solving
- Critical Thinking
- Information Technology Competence

2 Written and Coding Assessment 2

Assessment Type
Written Assessment

Task Description
This assessment will test students' understanding of inverse kinematics and robotic dynamics. The students are required to develop mathematical models for multi-link robotic manipulators and to develop simulation models in the Robotic Operating System (ROS) framework. The understanding of advanced ROS concepts will be needed for the successful completion of this assignment. The weekly interactive tutorials will cover these topics and the code skeleton for this assignment will be provided. The students are expected to prepare a report that includes code outputs, explanations and simulation results. The final submission must include the scripts, the simulation outputs and the report with the submission.

Assessment Due Date
Week 7 Friday (29 Apr 2022) 12:00 am AEST

Return Date to Students

Two weeks from submission

Weighting
20%

Minimum mark or grade
30%

Assessment Criteria
The following assessment requirements need to be fulfilled to obtain the full marks for this assessment.
1. Computer codes are properly commented and relevant coding practices are used
2. Developed mathematical models are accurate and output expected results
3. Computer code should not have any compilation errors
4. Software code output should match with the report and simulation results included in the submission
5. All working and assumptions must be shown

Referencing Style

- [Harvard (author-date)]

Submission
Online

Submission Instructions
One zip folder with the report, codes and simulation outputs. The software code needs to uploaded to the code repository.

Learning Outcomes Assessed

- Analyse robotic systems including robotic manipulators by using the knowledge of kinematics, dynamics, and coordinate system transformation
- Develop mathematical models to simulate robotic systems using Robotic Operating System (ROS)

Graduate Attributes

- Problem Solving
- Critical Thinking
- Information Technology Competence

3 Practical and Written assessment - Labs

Assessment Type
Practical and Written Assessment

Task Description
This assessment covers computer lab sessions and practicals with robots and is distributed in four lab assessments (labs 1 to 4). You are required to use specific software and simulation environment to complete each lab. Most of the labs can be run on the simulation environment. However, you need to attend the mandatory lab sessions that require robot interaction. The simulation work for labs needs to completed by week 9.
The details of these labs/practicals will be available from the unit Moodle website. The lab and practicals are compulsory (you need to pass these to pass the unit). Mixed-mode students complete the labs at the compulsory residential school. The lab reports have to be submitted individually and no team report will be accepted.

Assessment Due Date
Week 10 Friday (20 May 2022) 11:45 pm AEST

Return Date to Students

Two weeks after each submission

Weighting
20%

Minimum mark or grade
Combined marks of Labs 1 to 4 need to be 50% or more to pass the unit.

Assessment Criteria
The following assessment requirements need to be fulfilled to obtain the full marks for this assessment.

1. Correct answers including plots and figures
2. Readability and flow of the code (should be neat, tidy, and legible)
3. Computer codes should be properly commented and formatted
4. Computer code should not have any compilation errors
5. Software code output should match with the report and simulation results included in the submission
6. All working and assumptions must be shown

Referencing Style

- Harvard (author-date)

Submission
Online

Submission Instructions
One folder including pdf (solutions, any handwritten data, code, and its output) and simulation outputs.

Learning Outcomes Assessed

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

Graduate Attributes

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

4 Portfolio

Assessment Type
Portfolio

Task Description
The portfolio assessment in this unit corresponds mainly to the project and its report. The students are allowed to work in groups of 2 -3 students. This project will run as a robotic completion and will be task-based. Each student group needs to program robotics platforms to complete each task and points will be given for successful completion. The students are expected to start their group project work from week 4 and the final competition will be held on week 12. The portfolio needs to be individually submitted highlighting the individual's contribution (one portfolio per group is not allowed). The Project output needs to be demonstrated either in the simulation environment or using actual robots. The final codebase needs to be submitted to the assigned code repository. Peer evaluation will be done to identify the individual contribution of each member of the project.

Assessment Due Date
Week 12 Friday (3 June 2022) 3:00 pm AEST

The portfolio due in the exam Week. Robotic Competition will be held on week 12

Return Date to Students

This is the final assessment item and marks/feedback will be released after the grades are released.

Weighting
40%

Minimum mark or grade
50%

Assessment Criteria
The portfolio project will be assessed using the following assessment criteria
1. The Number of tasks successfully completed in the robotic competition
2. Project report is in the correct format and all sections are well explained
3. The individual contribution to the group project as demonstrated in the team report
4. Fulfilment of the assigned tasks as demonstrated by the group report
5. Computer codes are properly commented and relevant coding practices are used
The project report should contain the following:
1. All the assumptions, design details, code files, and results are included in the project report.
2. The report/portfolio should clearly indicate the individual work and contribution in the team project and also include the common report for the group.

Referencing Style

- Harvard (author-date)

Submission
Online

Submission Instructions
One folder containing pdf report (common and individual contribution) and software code with any other video file / output file

Learning Outcomes Assessed

- Program industrial robots using industry-standard programming software
- Develop control systems for robotics sub-systems by extracting information from sensors
- 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.

Graduate Attributes

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

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.

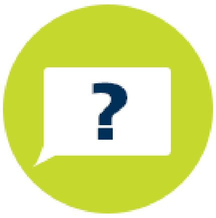
What is a breach of academic integrity?
A breach of academic integrity includes but is not limited to plagiarism, self-plagiarism, collusion, cheating, contract cheating, and academic misconduct. The Student Academic Integrity Policy and Procedure defines what these terms mean and gives examples.

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