ENEX13004 *Advanced Dynamics and Robotics*
Term 1 - 2020

Profile information current as at 14/12/2025 04:09 pm

Corrections

Unit Profile Correction added on 17-04-20
The lab assessments will be changed as per the details on Moodle unit website.

Unit Profile Correction added on 17-04-20
The project based portfolio's marking criteria is updated as per the details on Moodle unit website.

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 programing 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 surrounding environment by fusing information from various sensors attached to the robotic device. Students enrolled in distance mode are required to attend a compulsory Residential School.

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 - 2020

- 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 Unit feedback

Feedback
The integration of theoretical and practical aspect of robotics was appreciated in enhancing the learning experience.

Recommendation
Same practices will be continued with the efforts of improving them further.

Feedback from Unit feedback

Feedback
The learning outcome and course progression was much appreciated.

Recommendation
The same practices will be continued with the efforts of improving them further.

Feedback from Unit feedback

Feedback
More content on Python and Robotino coding environment is desired.

Recommendation
In addition to the sessions on Python, ROS, and Robotino coding currently in practice, some additional videos will be recorded with basic but relevant sample codes to give the students relevant understanding.

Feedback from Unit feedback

Feedback
The access to the robots were sometimes difficult.

Recommendation
The robots are available for use to on-campus students any day during the normal working hours and in a residential school for mix mode students. Access times will be communicated to the students at the start of the term through Moodle.

Feedback from Self reflection

Feedback
More detailed assessment requirements should be included.

Recommendation
More assessment details on how to attempt them and what is expected will be included in assessment write-up. Assessment requirements will also be discussed in class to make it more convenient for students.

Unit Learning Outcomes

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

1. Describe rigid body and multi-link motion dynamics, and coordinate system transformation
2. Apply knowledge of dynamics to analyse robotic systems including robotic manipulators and predict their trajectories
3. Develop mathematical models for robotic systems
4. Program industrial robots using industry standard programming software
5. Predict robot trajectories using multi sensor data fusion techniques
6. Solve real life problems and communicate professionally using robotic engineering terminology, symbols and diagrams that conform to Australian and international standards
7. Work individually and collaboratively in teams, communicate professionally in presenting your solutions

Learning outcomes are linked to Engineers Australia Stage 1 Competencies and also discipline capabilities. You can find the mapping for this on the Engineering Undergraduate Course website.

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 - 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	7
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%	•	•	•			•				

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

Textbooks and Resources

Textbooks

ENEX13004

Prescribed

Introduction to Robotics: Mechanics & Control Pearson New International Edition
Edition: 3rd (2013)
Authors: John J. Craig
Pearson Higher Ed USA
USA
ISBN: 9781292052526
Binding: Other
ENEX13004

Supplementary

Robotics, Vision and Control: Fundamental Algorithms in MATLAB
Edition: 2nd (2017)
Authors: Peter Corke
Springer
ISBN: 978-3-319-54412-0
Binding: Paperback

Additional Textbook Information

Textbooks
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In this unit we will be using materials from different resources to address the important aspects of robotics. The prescribed textbook would be your main resource but not all the chapters will be covered from it during the unit.
The supplementary book will be used to cover mostly the MatLab aspect of the unit. It is not mandatory to buy this book however, it is highly recommended due to its relevance to latest trends in robotics and modelling.
Your prescribed textbook is available for online purchase (as e-text) via:
http://www.pearson.com.au/9781292052526 However, if you prefer a paper text, they are still available at the CQUni Bookshop here: https//bookshop.cqu.edu.au (search on the Unit code)
Software
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1. MatLab with Robotics Toolbox and Vision Toolbox
(Please note that these toolboxes and the instructions on how to install them are available at the following URLs.
http://petercorke.com/wordpress/toolboxes/robotics-toolbox
http://petercorke.com/wordpress/toolboxes/machine-vision-toolbox#Downloading_the_Toolbox
For those who don't already have MatLab can buy student edition from this link:
https://au.mathworks.com/academia/student_version/?s_tid=tb_sv

2. Autodesk Inventor (or any other 3D modelling software)
(We will use the software for just a couple of topics in the unit. It would however introduce you to a professional software for 3D solid modelling. You can check if the software is available free of charge for students at the following site. You may need to create an account using cqu mail)
http://www.autodesk.com/education/free-software/inventor-professional?_ga=1.113196420.1238353875.1479429906

3. ROS Indigo with Python and C++ (rospy and roscpp)
(It is desired that you become familiar with ROS in this unit as we will use it to interact with Baxter robots. You can keep

both operating systems Ubuntu and Windows in your computers. Another way is to use Ubuntu virtual box on windows to run ROS.
http://wiki.ros.org/win_ros/Tutorials/WinRos%20and%20Virtual%20Ubuntu
The best way is to download the pre-installed virtual machine with ROS repositories loaded from Nootrix at:
https://www2.nootrix.com/downloads/#RosVM
ROS is freeware and is available at..)
http://wiki.ros.org/roscpp
http://wiki.ros.org/rospy

4. Robotino SIM
(For 3D simulation – basic level - of Robotino. Available at the following website)
http://www.festo-didactic.com/int-en/services/robotino/simulation/?fbid=aW50LmVuLjU1Ny4xNy4zNC4xNDQy

5. Robotino View 3
(For programming of Robotino. Available at the following website)
http://www.festo-didactic.com/int-en/services/robotino/programming/robotino-view/?fbid=aW50LmVuLjU1Ny4xNy4zNC4xNDI2

Note: Queries about the above software can be directed to me (unit coordinator) at u.izhar@cqu.edu.au

IT Resources
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- CQUniversity Student Email
- Internet
- Unit Website (Moodle)
- PC with listed (under textbooks and resources section) software installed

IT Resources

You will need access to the following IT resources:

- CQUniversity Student Email
- Internet
- Unit Website (Moodle)
- A computer with admin rights and software installed as per the software information under 'textbooks and resources'

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 2020

Module/Topic	Chapter	Events and Submissions/Topic
Robots, Joints, and D.O.F.	Chapter 1 (Introduction to Robotics by J.J. Craig)	

Week 2 - 16 Mar 2020

Module/Topic	Chapter	Events and Submissions/Topic

Robot Spatial Descriptions and Transformations - I	Chapter 2 (Introduction to Robotics by J.J. Craig)	

Week 3 - 23 Mar 2020

Module/Topic	Chapter	Events and Submissions/Topic
> Robot Spatial Descriptions and Transformations - II > Robot Modeling > Forward Kinematics	Chapters 2 and 3 (Introduction to Robotics by J.J. Craig)	

Week 4 - 30 Mar 2020

Module/Topic	Chapter	Events and Submissions/Topic
Forward and Inverse Kinematics	Chapters 3 and 4 (Introduction to Robotics by J.J. Craig)	

Week 5 - 06 Apr 2020

Module/Topic	Chapter	Events and Submissions/Topic
Manipulator Trajectory	Chapter 7 (Introduction to Robotics by J.J. Craig)	**Written Assessment 1** Due: Week 5 Monday (6 Apr 2020) 11:55 pm AEST

Vacation Week - 13 Apr 2020

Module/Topic	Chapter	Events and Submissions/Topic

Week 6 - 20 Apr 2020

Module/Topic	Chapter	Events and Submissions/Topic
Programming Robots	Chapter 12 (Introduction to Robotics by J.J. Craig) Additional Resources	Submit 1-page project proposal with scope.

Week 7 - 27 Apr 2020

Module/Topic	Chapter	Events and Submissions/Topic
Image Processing	Chapters 12 and 13 (Robotic Vision and Control by Peter Corke)	

Week 8 - 04 May 2020

Module/Topic	Chapter	Events and Submissions/Topic
Mobile Robots	Chapter 4 (Robotic Vision and Control by Peter Corke)	Labs 1 and 2 Due - Week 8 Friday (08 May 2020), 11:55PM AEST

Week 9 - 11 May 2020

Module/Topic	Chapter	Events and Submissions/Topic
Robot Navigation	Chapter 5 (Robotic Vision and Control by Peter Corke)	Submit project methodology and code flowcharts

Week 10 - 18 May 2020

Module/Topic	Chapter	Events and Submissions/Topic
Manipulator Mechanism Design	Chapter 8 (Introduction to Robotics by J.J. Craig)	**Written Assessment 2** Due: Week 10 Monday (18 May 2020) 11:55 pm AEST

Week 11 - 25 May 2020

Module/Topic	Chapter	Events and Submissions/Topic
Manipulator Dynamics	Chapters 5 and 6 (Introduction to Robotics by J.J. Craig)	Labs 3 and 4 Due - Week 11, Monday (25 May 2020, 11:55PM AEST)

Week 12 - 01 Jun 2020

Module/Topic	Chapter	Events and Submissions/Topic
Miscellaneous Topics		

Review/Exam Week - 08 Jun 2020

Module/Topic	Chapter	Events and Submissions/Topic

Exam Week - 15 Jun 2020

Module/Topic	Chapter	Events and Submissions/Topic
		Portfolio Due - Exam Week, Tuesday (16 June 2020), 11:55PM AEST

Term Specific Information

Remember that the residential school is compulsory for this unit. See schedule for the residential school through University handbook and contact unit coordinator for any specific information about the unit. All assessments have 'minimum marks to pass conditions'. Please refer to the individual assessment for more details.

Assessment Tasks

1 Written Assessment 1

Assessment Type
Written Assessment

Task Description
This assessment will consist of numerical problems with some having MatLab implementation. The assessment questions and criteria would be available in Moodle before start of the term. Students are not expected to use word editor as a must for this task. Clear and legible scanned handwritten document in pdf format is acceptable. For questions that require scripting and coding in MatLab, students must include the script and the corresponding script output with the submission.

Assessment Due Date
Week 5 Monday (6 Apr 2020) 11:55 pm AEST

Return Date to Students
Week 7 Monday (27 Apr 2020)

Weighting
20%

Minimum mark or grade
30%

Assessment Criteria
1. Correct answers / solutions,
2. Correct format of each question attempted and the assignment as a whole,
3. All working and assumptions must be shown to obtain full marks,
4. Computer codes should be properly commented and relevant output is included,
5. Submission is neat, tidy, and legible.

Referencing Style

- Harvard (author-date)

Submission
Online

Submission Instructions
One pdf file including solutions, any handwritten data, code, and its output (if required).

Learning Outcomes Assessed

- Describe rigid body and multi-link motion dynamics, and coordinate system transformation
- Apply knowledge of dynamics to analyse robotic systems including robotic manipulators and predict their trajectories
- Develop mathematical models for robotic systems

Graduate Attributes

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

2 Written Assessment 2

Assessment Type
Written Assessment

Task Description
This assessment will consist of numerical problems with some having MatLab implementation. The assessment questions and criteria would be available in Moodle before start of the term. Students are not expected to use word editor as a must for this task. Clear and legible scanned handwritten document in pdf format is acceptable. For questions that require scripting and coding in MatLab, students must include the script and the corresponding script output with the submission.

Assessment Due Date
Week 10 Monday (18 May 2020) 11:55 pm AEST

Return Date to Students
Exam Week Monday (15 June 2020)

Weighting
20%

Minimum mark or grade
30%

Assessment Criteria
1. Correct answers / solutions,
2. Correct format of each question attempted and the assignment as a whole,
3. All working and assumptions must be shown to obtain full marks,
4. Computer codes should be properly commented and relevant output is included,
5. Submission is neat, tidy, and legible.

Referencing Style

- Harvard (author-date)

Submission
Online

Submission Instructions
One pdf file including solutions, any handwritten data, code, and its output (if required).

Learning Outcomes Assessed

- Describe rigid body and multi-link motion dynamics, and coordinate system transformation
- Apply knowledge of dynamics to analyse robotic systems including robotic manipulators and predict their trajectories
- Develop mathematical models for robotic systems

Graduate Attributes

- Communication
- 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 are distributed in four lab assessments (labs 1 to 4). You are required to use specific software environment to complete each lab. Most of the labs are pre-recorded for your reference however you need to attend the mandatory residential school for the lab sessions that

require robot interaction. The submission is distributed in two parts; labs 1 & 2 should be submitted by week 8 and labs 3 & 4 by week 11.
The details of these labs/practicals will be available from the unit Moodle website at the start of the term. 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

Labs 1 and 2 - Friday, Week 8 (08/05/2020, 11:55PM AEST). Labs 3 and 4 - Monday, Week 11 (25/05/2020, 11:55PM 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
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,

Referencing Style

- Harvard (author-date)

Submission
Online

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

Learning Outcomes Assessed

- Program industrial robots using industry standard programming software
- Predict robot trajectories using multi sensor data fusion techniques
- Solve real life problems and communicate professionally using robotic engineering terminology, symbols and diagrams that conform to Australian and international standards
- Work individually and collaboratively in teams, communicate professionally in presenting your solutions

Graduate Attributes

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

4 Portfolio

Assessment Type
Portfolio

Task Description
The portfolio assessment in this unit corresponds mainly to the project and its report. You can propose your own project or choose from a list of sample projects provided on Moodle website.

Assessment Due Date

Exam Week - Tuesday 16/06/2020 - 11:55PM AEST

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
1. You are allowed to work in groups of 2 (3 if necessary).
2. Portfolio will be individually submitted highlighting the individual's contribution (one portfolio per group is not allowed)
The project report should at least contain the following:
1. You will document all the assumptions, design details, code files, and results 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

- Describe rigid body and multi-link motion dynamics, and coordinate system transformation
- Apply knowledge of dynamics to analyse robotic systems including robotic manipulators and predict their trajectories
- Develop mathematical models for robotic systems
- Program industrial robots using industry standard programming software
- Predict robot trajectories using multi sensor data fusion techniques
- Solve real life problems and communicate professionally using robotic engineering terminology, symbols and diagrams that conform to Australian and international standards
- Work individually and collaboratively in teams, communicate professionally in presenting your solutions

Graduate Attributes

- Communication
- Problem Solving
- Critical Thinking
- Team Work
- Information Technology Competence
- Cross Cultural 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