ENEX13004 *Advanced Dynamics and Robotics*
Term 1 - 2017

Profile information current as at 14/05/2024 03:53 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 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 - 2017

- Distance
- Mackay

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 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.

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	•	•	•	•	•	•	•

Graduate Attributes	Learning Outcomes						
	1	2	3	4	5	6	7
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

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

Supplementary

Robotics, Vision and Control: Fundamental Algorithms in MATLAB
Edition: 1 (2011)
Authors: Peter Corke
Springer
USA
ISBN: 978-3-642-20143-1
Binding: Paperback

Additional Textbook Information

Textbooks

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.

1. The prescribed book is available as an online purchase via: http://www.pearson.com.au/9781292052526
Title: Introduction to Robotics: Mechanics & Control Pearson New International Edition VitalSource eText (3e)
Author: John J. Craig
Edition: 3rd
ISBN: 9781292052526
2. The supplementary book is available for purchase at: http://www.springer.com/gp/book/9783642201431
Title: Robotics, Vision and Control: Fundamental Algorithms in MATLAB
Author: Peter Corke
Edition: 1st (2011) / or latest
ISBN - 978-3-642-20143-1
Published by Springer
The book is also availabe on Amazon:
https://www.amazon.com/Robotics-Vision-Control-Fundamental-Algorithms/dp/3642201431/ref=as_sl_pc_tf_til?tag=petercorke05-20&linkCode=w00&linkId=bf0c2242fd360a50aec0fb29ff2a0321&creativeASIN=3642201431

Software

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://www.petercorke.com/RTB/
http://www.petercorke.com/MVTB/
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
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
> Queries about the above software can be directed to me (unit coordinator) at u.izhar@cqu.edu.au

IT

1. CQ University Email
2. Internet
3. Course website (Moodle)
4. Windows PC with USB and LAN ports
5. PC with listed software installed

View textbooks at the CQUniversity Bookshop

IT Resources

You will need access to the following IT resources:

- CQUniversity Student Email
- Internet
- Unit Website (Moodle)
- Computer with windows 7, camera / web camera for images, usb port
- Software access as per the description under Software section

Referencing Style

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

Teaching Contacts

Umer Izhar Unit Coordinator
u.izhar@cqu.edu.au

Schedule

Week 1 - 06 Mar 2017

Module/Topic	Chapter	Events and Submissions/Topic
Robots, Joints, and Degrees of Freedom	Chapter 1 (Introduction to Robotics by J. J. Craig) Chapter 2 (CRO - Design of Machinery by R.L. Norton) Lecture Slides	3D print / 2D print axis for reference

Week 2 - 13 Mar 2017

Module/Topic	Chapter	Events and Submissions/Topic
Robot Spatial Descriptions and Transformations - I	Chapter 2 (Introduction to Robotics by J. J. Craig) Lecture Slides	

Week 3 - 20 Mar 2017

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

Week 4 - 27 Mar 2017

Module/Topic	Chapter	Events and Submissions/Topic
Forward Kinematics	Chapter 3 (Introduction to Robotics by J. J. Craig) Lecture Slides	

Week 5 - 03 Apr 2017

Module/Topic	Chapter	Events and Submissions/Topic
Inverse Kinematics	Chapter 4 (Introduction to Robotics by J. J. Craig) Lecture Slides	**Written Assessment 1** Due: Week 5 Friday (7 Apr 2017) 4:00 pm AEST

Vacation Week - 10 Apr 2017

Module/Topic	Chapter	Events and Submissions/Topic

Week 6 - 17 Apr 2017

Module/Topic	Chapter	Events and Submissions/Topic
Programming Robots	Chapter 12 (Introduction to Robotics by J. J. Craig) Study Guide Lecture Slides	

Week 7 - 24 Apr 2017

Module/Topic	Chapter	Events and Submissions/Topic

Manipulator Trajectory	Chapter 7 (Introduction to Robotics by J. J. Craig) Lecture Slides	

Week 8 - 01 May 2017

Module/Topic	Chapter	Events and Submissions/Topic
Mobile Robots	Chapter 4 (Robotic Vision and Control by Peter Corke) Lecture Slides	Submit Labs 1 and 2 (1/2 of Practical and Written Assessment) Due Friday (05 May 17) 04:00 PM AEST

Week 9 - 08 May 2017

Module/Topic	Chapter	Events and Submissions/Topic
Image Processing and Robot Navigation	Chapter 12 and 13 - Image Processing Chapter 5 - Navigation (Robotic Vision and Control by Peter Corke) Lecture Slides	

Week 10 - 15 May 2017

Module/Topic	Chapter	Events and Submissions/Topic
3D CAD Modeling of Robot Links	Study Guide Lecture Slides / Video	**Written Assessment 2** Due: Week 10 Friday (19 May 2017) 4:00 pm AEST

Week 11 - 22 May 2017

Module/Topic	Chapter	Events and Submissions/Topic
Manipulator Mechanism Design	Chapter 8 (Introduction to Robotics by J. J. Craig) Lecture Slides	

Week 12 - 29 May 2017

Module/Topic	Chapter	Events and Submissions/Topic
Miscellaneous Topics and Revision	Lecture Slides	Submit Labs 3 and 4 (2/2 of Practical and Written Assessment) Due Monday (02 Jun 17) 04:00 PM AEST

Review/Exam Week - 05 Jun 2017

Module/Topic	Chapter	Events and Submissions/Topic

Exam Week - 12 Jun 2017

Module/Topic	Chapter	Events and Submissions/Topic
		Portfolio Due: Exam Week Monday (12 June 2017) 4:00 pm AEST

Term Specific Information

In this unit we will be using materials from different resources to address the important aspects of robotics. It is highly recommended that you read information about the textbooks and software, given under textbook and resources tab. Further guidelines about the course in general can be found on Moodle course website. Students are advised and encouraged to use Q&A forum for queries about assignments, labs, software etc.
The labs and practicals are an essential part of this unit and are therefore mandatory for all students. For that matter a mandatory residential school is arranged (refer residential school schedule and course website for dates) for flex students. This residential school will be held at Mackay, Ooralea campus.

Assessment Tasks

1 Written Assessment 1

Assessment Type
Written Assessment

Task Description
This assessment would cover the topics from first four weeks of this unit and will consist of numerical problems. The assessment criteria would be provided with the questions well before the submission date and would be strictly followed. The students are not expected to use word editor for this task, instead they can scan a clear and legible handwritten document and submit it as a pdf file. Some questions however, require scripting and coding in MatLab, so students have to include the script with necessary script output in the submission.

Assessment Due Date
Week 5 Friday (7 Apr 2017) 4:00 pm AEST

Return Date to Students

In 2 weeks of submission

Weighting
20%

Assessment Criteria
1. Correct Answers,
2. Correct format of the questions and the submission itself (cover page, page orientation and numbering, file name etc.)
3. *All working* must be shown to obtain full marks,
4. Assignment answers must be neat, tidy and legible.
5. Computer codes should be properly commented and formatted.

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 would cover the topics inverse kinematics and mobile robots and will consist of numerical problems. The assessment criteria would be provided with the questions well before the submission date and would be strictly followed. The students are not expected to use word editor for this task, instead they can scan a clear and legible handwritten document and submit it as a pdf file. Some questions however, require scripting and coding in MatLab, so students have to include the script with necessary script output in the submission.

Assessment Due Date
Week 10 Friday (19 May 2017) 4:00 pm AEST

Return Date to Students

Within 2 weeks after due date

Weighting
20%

Assessment Criteria
1. Correct Answers,
2. Correct format of the questions and the submission itself (cover page, page orientation and numbering, file name etc.)
3. *All working* must be shown to obtain full marks,
4. Assignment answers must be neat, tidy and legible.
5. Computer codes should be properly commented and formatted.

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

Assessment Type
Practical and Written Assessment

Task Description
This assessment corresponds to computer lab sessions and practicals with robots covering almost all topics in the unit such as robot kinematics, image processing and navigation techniques etc. You will need to use Robotics and Vision toolboxes in Matlab to complete the labs. Supervised labs with practice exercises will be held in the lab time as directed by unit website or unit coordinator.
The submission is distributed in two chunks, you have to submit labs 1 and 2 by week 8 and labs 3 & 4 by week 12. 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) for every student, for this reason Residential school is scheduled for distance students.
The lab reports have to be **submitted individually** and no team report will be accepted.

Assessment Due Date

Labs 1-2 (Week 8 - Friday 16:00 AEST), Labs 3-4 (Week 12 - Monday 16:00 AEST)

Return Date to Students

Within 2 weeks after due date

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

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

- 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 will propose your own or choose from sample projects (a list of ideas will be given with the assessment instructions on Moodle website) that will be due in the Exam week.

Portfolio / Report Requirements
1. You are allowed to work in groups of 2 to 3.
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 project report should also include the evidence of at least one activity related to each learning outcome of the unit. You will be required to include a matrix showing that you addressed the learning outcome at a specific location in the report.
3. The report / portfolio should clearly indicate the individual work and contribution in the team project.

Assessment Due Date
Exam Week Monday (12 June 2017) 4:00 pm AEST

Return Date to Students

Within 2 weeks after due date

Weighting
40%

Minimum mark or grade
50% marks required to pass the unit

Assessment Criteria
The portfolio will be assessed using the rubrics provided on Moodle unit website. The details are given in the rubrics however the components that will be evaluated are broadly presented here:
1. Research and investigation of the topic, scoping
2. Technical Design
3. Use of modern tools (software, hardware)
4. Project work addresses unit learning outcomes

5. Output and Results
6. 50% grade is required to pass the unit

Referencing Style

- Harvard (author-date)

Submission
Online

Submission Instructions
One folder containing pdf report 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