ENEX13004 *Advanced Dynamics and Robotics*
Term 1 - 2019

Profile information current as at 14/05/2024 11:26 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 - 2019

- 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).

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.

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 Moodle student feedback survey

Feedback
Matlab and Robot Operating System (ROS) labs were very useful and effective.

Recommendation
Will carry on with these labs to provide students to simulate and interact with physical robots.

Feedback from Moodle student feedback survey

Feedback
Residential school activity was very useful.

Recommendation
The 3-day residential school allows students to effectively implement their concepts on the equipment.

Feedback from Moodle student feedback survey

Feedback
More resources on ROS or Ubuntu system will be helpful.

Recommendation
Links to the major repository of ROS and Ubuntu codes and tutorials were already presented to students. In the future, the students will be specifically directed to the available resources.

Feedback from Moodle student feedback survey

Feedback
More weightage to labs should be given rather than the assignments.

Recommendation
The current weight will be reviewed and updated if required.

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%	•	•	•			•				
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
****
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://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

You will need access to the following IT resources:

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

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 - 11 Mar 2019

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	

Week 2 - 18 Mar 2019

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 - 25 Mar 2019

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

Week 4 - 01 Apr 2019

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

Week 5 - 08 Apr 2019

Module/Topic	Chapter	Events and Submissions/Topic
Manipulator Trajectory	Chapter 7 (Introduction to Robotics by J. J. Craig) Lecture Slides	Computer Lab session on Kinematics and Trajectory **Written Assessment 1** Due: Week 5 Monday (8 Apr 2019) 11:55 pm AEST

Vacation Week - 15 Apr 2019

Module/Topic	Chapter	Events and Submissions/Topic

Week 6 - 22 Apr 2019

Module/Topic	Chapter	Events and Submissions/Topic
Programming Robots	Chapter 12 (Introduction to Robotics by J. J. Craig) Study Guide Lecture Slides	Computer Lab session on Python/ROS

Week 7 - 29 Apr 2019

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

Week 8 - 06 May 2019

Module/Topic	Chapter	Events and Submissions/Topic
Mobile Robots	Chapter 4 (Robotic Vision and Control by Peter Corke) Lecture Slides	Computer Lab session on Image Processing Submit Labs 1 and 2 (1/2 of Practical and Written Assessment) Due Friday (10 May 19) 11:55 PM AEST

Week 9 - 13 May 2019

Module/Topic	Chapter	Events and Submissions/Topic
Robot Navigation	Chapter 5 (Robotic Vision and Control by Peter Corke) Lecture Slides	Recorded Lab session on path planning **Written Assessment 2** Due: Week 9 Friday (17 May 2019) 11:55 pm AEST

Week 10 - 20 May 2019

Module/Topic	Chapter	Events and Submissions/Topic
Manipulator Mechanism Design	Chapter 8 (Introduction to Robotics by J. J. Craig) Lecture Slides	Lab session with Baxter and Robotino Residential School

Week 11 - 27 May 2019

Module/Topic	Chapter	Events and Submissions/Topic
Manipulator Dynamics	Chapters 5 and 6 (Introduction to Robotics by J. J. Craig) Lecture Slides	Submit Labs 3 and 4 (2/2 of Practical and Written Assessment) Due Monday (27 May 19) 11:55 PM AEST

Week 12 - 03 Jun 2019

Module/Topic	Chapter	Events and Submissions/Topic
Miscellaneous Topics and Revision	Lecture Slides	

Review/Exam Week - 10 Jun 2019

Module/Topic	Chapter	Events and Submissions/Topic
		Submit Individual Portfolio Due Friday (16 Jun 19) 11:55PM AEST

Exam Week - 17 Jun 2019

Module/Topic	Chapter	Events and Submissions/Topic

Term Specific Information

The unit has variety of topics which are mainly covered (but not fully) from the prescribed textbook. Remember that the residential school is compulsory for this unit. Moreover, 50% marks is required in Labs (collectively) and Portfolio to pass the unit. See schedule for the residential school through University handbook and contact unit coordinator for any specific information about the unit.

Assessment Tasks

1 Written Assessment 1

Assessment Type
Written Assessment

Task Description
This assessment will consist of numerical problems. 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 (8 Apr 2019) 11:55 pm AEST

Return Date to Students
Week 7 Monday (29 Apr 2019)

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 will consist of numerical problems. 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 9 Friday (17 May 2019) 11:55 pm AEST

Return Date to Students
Week 11 Friday (31 May 2019)

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 covers computer lab sessions and practicals with robots. You are required to use Robotics and Vision toolboxes in Matlab to complete these labs. Lab schedule will be available on the unit website and in the timetable. 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). Online 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 1-2 (Week 8 - Friday 11:55 PM AEST), Labs 3-4 (Week 11 - Monday 11:55 PM AEST)

Return Date to Students

Within 2 weeks of 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
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 folder including pdf (solutions, any handwritten data, code and its output) and any animation

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
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.
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 / Review Week - Friday 16th June 2019 - 11:55PM AEST

Return Date to Students

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

Weighting
40%

Minimum mark or grade
50% marks required to pass

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% mark 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