



# ENEX13005 *Machine Design and Vibrations*

## Term 1 - 2024

Profile information current as at 02/05/2024 03:09 am

All details in this unit profile for ENEX13005 have been officially approved by CQUniversity and represent a learning partnership between the University and you (our student). The information will not be changed unless absolutely necessary and any change will be clearly indicated by an approved correction included in the profile.

## General Information

### Overview

This unit will introduce you to the fundamental synthesis of mechanisms and machines. You will start by carrying out analysis of linkages in terms of their transmission angles, toggle positions and mobility for a certain mechanism. The kinematic analysis of any mechanism requires an acceleration analysis that depends on its position and velocity. You will be able to carry out this position, velocity, and acceleration analysis of these mechanisms (kinematic systems) using analytical equations and graphical methods. This unit will enable you to work on 3D CAD modelling and computer simulation of various mechanisms or machines. You will move on to kinetic analysis of systems thereby discussing static and dynamic balancing of rotating masses. After learning concepts of dynamics, you will study vibrations (free and forced) of single and multi-degree of freedom systems and will be able to carry out analysis of such systems using force and energy methods. 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

MATH11219 Applied Calculus AND [ENEM12007 Statics & Dynamics OR ENEM12010 Engineering Dynamics].

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 - 2024

- 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. **Online Quiz(zes)**

Weighting: 20%

#### 2. **Written Assessment**

Weighting: 15%

#### 3. **Written Assessment**

Weighting: 20%

#### 4. **Practical Assessment**

Weighting: 15%

#### 5. **Portfolio**

Weighting: 30%

### Assessment Grading

This is a graded unit: your overall grade will be calculated from the marks or grades for each assessment task, based on the relative weightings shown in the table above. You must obtain an overall mark for the unit of at least 50%, or an overall grade of 'pass' in order to pass the unit. If any 'pass/fail' tasks are shown in the table above they must also be completed successfully ('pass' grade). You must also meet any minimum mark requirements specified for a particular assessment task, as detailed in the 'assessment task' section (note that in some instances, the minimum mark for a task may be greater than 50%). Consult the [University's Grades and Results Policy](#) for more details of interim results and final grades.

## CQUniversity Policies

**All University policies are available on the [CQUniversity Policy site](#).**

You may wish to view these policies:

- Grades and Results Policy
- Assessment Policy and Procedure (Higher Education Coursework)
- Review of Grade Procedure
- Student Academic Integrity Policy and Procedure
- Monitoring Academic Progress (MAP) Policy and Procedure – Domestic Students
- Monitoring Academic Progress (MAP) Policy and Procedure – International Students
- Student Refund and Credit Balance Policy and Procedure
- Student Feedback – Compliments and Complaints Policy and Procedure
- Information and Communications Technology Acceptable Use Policy and Procedure

This list is not an exhaustive list of all University policies. The full list of University policies are available on the [CQUniversity Policy site](#).

## Previous Student Feedback

### Feedback, Recommendations and Responses

Every unit is reviewed for enhancement each year. At the most recent review, the following staff and student feedback items were identified and recommendations were made.

#### Feedback from SUTE unit comments report

##### **Feedback**

Students complimented the delivery of live lectures in which students were able to communicate with the unit coordinator.

##### **Recommendation**

The unit coordinator should continue to deliver live lectures for better engagement and learning experiences.

## Unit Learning Outcomes

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

1. Apply key concepts of kinetics and kinematics to analyse machine design and synthesis
2. Use analytical and graphical techniques to carry out position, velocity, and acceleration analysis
3. Apply concepts of dynamics in balancing of rotating components
4. Analyse vibrations in single and multiple degree of freedom systems
5. Communicate professionally using relevant technical terminology, symbols, and diagrams and effectively document calculations and solutions
6. Work autonomously and as a team member to analyse problems and present solutions.

**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**

**1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline. (LO: 1I 2I 3I 4I)**

**1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline. (LO: 1I 2I 3I 4I)**

#### **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 2A 3A 4I)**

**1.4 Discernment of knowledge development and research directions within the engineering discipline. (LO: 1A 4A)**

**1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline. (LO: 1A 4A)**

**1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline. (LO: 5A 6A)**

**2.1 Application of established engineering methods to complex engineering problem-solving.**

**(LO: 1A 2A 3A 4A 6A)**

**2.2 Fluent application of engineering techniques, tools and resources. (LO: 4A)**

**2.3 Application of systematic engineering synthesis and design processes. (LO: 6A)**

**2.4 Application of systematic approaches to the conduct and management of engineering projects. (LO: 5A 6A)**

**3.2 Effective oral and written communication in professional and lay domains. (LO: 5A 6A)**

**3.4 Professional use and management of information. (LO: 5A 6A)**

**3.5 Orderly management of self, and professional conduct. (LO: 6A)**

**3.6 Effective team membership and team leadership. (LO: 6A)**

***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



### Alignment of Assessment Tasks to Learning Outcomes

Assessment Tasks	Learning Outcomes					
	1	2	3	4	5	6
1 - Online Quiz(zes) - 20%	•	•				
2 - Written Assessment - 15%	•	•				
3 - Written Assessment - 20%			•	•		
4 - Practical Assessment - 15%					•	•
5 - Portfolio - 30%			•	•	•	•

### 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						

## Textbooks and Resources

### Textbooks

ENEX13005

#### Supplementary

##### Design of Machinery

Edition: 6th edn ISE (2020)

Authors: Robert L. Norton

McGraw Hill

ISBN: 9781260590845

Binding: Paperback

ENEX13005

#### Supplementary

##### Mechanical Vibrations

Edition: 6th edn (2017)

Authors: Singiresu S. Rao

Pearson Education

ISBN: 9781292178608

Binding: Paperback

### IT Resources

**You will need access to the following IT resources:**

- CQUniversity Student Email
- Internet
- Unit Website (Moodle)

## Referencing Style

All submissions for this unit must use the referencing style: [Harvard \(author-date\)](#)

For further information, see the Assessment Tasks.

## Teaching Contacts

**Jay Sul** Unit Coordinator

[j.sul@cqu.edu.au](mailto:j.sul@cqu.edu.au)

## Schedule

### Week 1 - 04 Mar 2024

Module/Topic	Chapter	Events and Submissions/Topic
Introduction and Kinematics fundamentals		
• Introduction to the unit and information session		
• Introduction to the machine design and vibration		
• Applications of kinematics		
• DoF in 2D and types of motion		
• Joints, links and kinematic diagrams		

### Week 2 - 11 Mar 2024

Module/Topic	Chapter	Events and Submissions/Topic
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Graphical linkage synthesis

- Linkage synthesis - Graphical, manual and dimensional techniques with examples
- Two-position synthesis
- Three-position synthesis

**Week 3 - 18 Mar 2024**

Module/Topic	Chapter	Events and Submissions/Topic
Position analysis of linkages		
<ul style="list-style-type: none"> <li>• Types of motion</li> <li>• Position analysis - Graphical, algebraic and vector loop methods for four-bar linkages and four-bar-crank slider</li> </ul>		

**Week 4 - 25 Mar 2024**

Module/Topic	Chapter	Events and Submissions/Topic
Analytical linkage synthesis		
<ul style="list-style-type: none"> <li>• 2 and 3 position motion generation by analytical and graphical synthesis</li> <li>• 4 and 5 position motion generation using analytical synthesis</li> </ul>		

**Week 5 - 01 Apr 2024**

Module/Topic	Chapter	Events and Submissions/Topic
Velocity analysis of linkages		
<ul style="list-style-type: none"> <li>• Recap of Engineering Dynamics</li> <li>• Graphical (vector) and instant centre methods (Kennedy's theorem)</li> <li>• Mechanical advantages</li> </ul>		

**Vacation Week - 08 Apr 2024**

Module/Topic	Chapter	Events and Submissions/Topic
		<b>Online Quiz - Kinematic analysis of linkages</b> Due: Vacation Week Monday (8 Apr 2024) 11:59 pm AEST

**Week 6 - 15 Apr 2024**

Module/Topic	Chapter	Events and Submissions/Topic
Acceleration analysis of linkages		
<ul style="list-style-type: none"> <li>• Graphical (vector) and analytical methods</li> <li>• Coriolis acceleration</li> </ul>		

**Week 7 - 22 Apr 2024**

Module/Topic	Chapter	Events and Submissions/Topic
Dynamics fundamentals		
<ul style="list-style-type: none"> <li>• Lumped models</li> <li>• Kinetics</li> <li>• Virtual work</li> </ul>		<b>Interim report - Design of a universal PV solar panel cleaner</b> Due: Week 7 Monday (22 Apr 2024) 11:59 pm AEST

**Week 8 - 29 Apr 2024**

Module/Topic	Chapter	Events and Submissions/Topic
Static and Dynamic balancing		
<ul style="list-style-type: none"> <li>• Static and dynamic balancing on rotating masses</li> <li>• Effect of balancing on shaking and input torque</li> </ul>		

**Week 9 - 06 May 2024**

Module/Topic	Chapter	Events and Submissions/Topic

Basic concepts of vibration

- Importance and types of vibration
- Natural frequency
- Critical damping and damping ratio
- Introduction to mathematical modelling and Laplace transform

#### Week 10 - 13 May 2024

Module/Topic	Chapter	Events and Submissions/Topic
Free and forced vibration <ul style="list-style-type: none"><li>• Forced harmonic vibration and resonance</li><li>• Logarithmic decrement</li><li>• Support motion</li><li>• Rotating unbalance</li></ul>		Residential School, 13 May

#### Week 11 - 20 May 2024

Module/Topic	Chapter	Events and Submissions/Topic
Transient vibration <ul style="list-style-type: none"><li>• Stability of a system</li><li>• Poles and Zeros</li><li>• Root Locus</li><li>• Bode plot</li></ul>		<b>Design of a suspension system</b> Due: Week 11 Friday (24 May 2024) 11:59 pm AEST

#### Week 12 - 27 May 2024

Module/Topic	Chapter	Events and Submissions/Topic
Two degree-of-freedom system <ul style="list-style-type: none"><li>• 2 DoF undamped free vibration</li><li>• 2 DoF damped free vibration</li><li>• 2 DoF forced vibration</li><li>• 2 DoF translational and rotational</li></ul>		<b>Laboratory worksheet</b> Due: Week 12 Friday (31 May 2024) 11:59 pm AEST

#### Review/Exam Week - 03 Jun 2024

Module/Topic	Chapter	Events and Submissions/Topic
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#### Exam Week - 10 Jun 2024

Module/Topic	Chapter	Events and Submissions/Topic
		<b>Final report for Design of a walking mechanism with minimum imbalance and vibration</b> Due: Exam Week Monday (10 June 2024) 11:59 pm AEST

## Assessment Tasks

### 1 Online Quiz - Kinematic analysis of linkages

#### Assessment Type

Online Quiz(zes)

#### Task Description

This assignment assesses students with the content from Week 1 to Week 4. You must provide detailed solutions to the problems given in the assignment in order to demonstrate your knowledge and understanding of the concepts and processes incorporating relevant sketches, clear step-by-step solutions and conclusion/judgement on answers.

#### Number of Quizzes

1

#### Frequency of Quizzes

#### Assessment Due Date

Vacation Week Monday (8 Apr 2024) 11:59 pm AEST

You get unlimited attempts until the due date.



## Return Date to Students

Students will get their results immediately after the due time, except for their sketches.

### Weighting

20%

### Minimum mark or grade

40% of allocated marks for this assessment

### Assessment Criteria

- Correctly identify the problem to be solved (key terms, units, elements, or parts of a problem)
- Choose the most appropriate approach to solving the problem
- Clearly present the solutions with sketches (if necessary) for the problems
- Attempt logical alternative approaches to solving the problem

### Referencing Style

- [Harvard \(author-date\)](#)

### Submission

Online

### Submission Instructions

Students to finish their unlimited attempts for online quizzes through unit's Moodle site

### Learning Outcomes Assessed

- Apply key concepts of kinetics and kinematics to analyse machine design and synthesis
- Use analytical and graphical techniques to carry out position, velocity, and acceleration analysis

## 2 Interim report - Design of a universal PV solar panel cleaner

### Assessment Type

Written Assessment

### Task Description

**Task 1:** Design (or find) a 1 (or 2) DOF walking mechanism that is reasonably simple but still functional. You will need to assume the working condition of the walking mechanism, such as its walking speed, motor speed, and weight and materials of each link and the main body. This task will need to be completed concurrently with Task 2.

**Task 2:** Demonstrate the kinematic and kinetic analysis of the design of your choice. This task will need to be completed concurrently with Task 1.

### Assessment Due Date

Week 7 Monday (22 Apr 2024) 11:59 pm AEST

Peer and self-assessment task to be completed by Week 7

### Return Date to Students

Week 8 Monday (29 Apr 2024)

Students to see feedback through the submission link.

### Weighting

15%

### Assessment Criteria

You are required to assess your peers' interim reports as well as your own according to the following marking guidelines and are expected to provide sincere feedback and accurate marks for your peers. This is a valuable chance for reflection after viewing other submissions. 67% of this assessment will be from the marks from your peers and the rest will be from the quality of your feedback to your peers.

- Presentation (/20)
- Context and aims (/20)
- Design of a mechanism and kinematic diagram (/20)
- Kinematic analysis and verification process (/20)
- Discussions and conclusions (/10)
- Progress (/10)

## Referencing Style

- [Harvard \(author-date\)](#)

### Submission

Online

### Submission Instructions

Submission to be made through a link provided in unit's Moodle site

### Learning Outcomes Assessed

- Apply key concepts of kinetics and kinematics to analyse machine design and synthesis
- Use analytical and graphical techniques to carry out position, velocity, and acceleration analysis

## 3 Design of a suspension system

### Assessment Type

Written Assessment

### Task Description

**Task 1:** Design of a shock absorber system for a Segway patroller - Find the necessary stiffness and damping constant of the shock absorber system under the given conditions.

**Task 2:** Demonstrate the performance of your design - The new Segway patroller with your suspension system is to be tested on a rough road whose surface varies sinusoidally.

### Assessment Due Date

Week 11 Friday (24 May 2024) 11:59 pm AEST

### Return Date to Students

Exam Week Friday (14 June 2024)

Students to see feedback through the submission link

### Weighting

20%

### Minimum mark or grade

40% of allocated marks for this assessment

### Assessment Criteria

- Presentation (/25%)
- Introduction and background (/15%)
- Methods and results (/25%)
- Discussion (/20%)
- Conclusions (/15%)

## Referencing Style

- [Harvard \(author-date\)](#)

### Submission

Online

### Submission Instructions

Submission to be made through a link provided in unit's Moodle site

### Learning Outcomes Assessed

- Apply concepts of dynamics in balancing of rotating components
- Analyse vibrations in single and multiple degree of freedom systems

## 4 Laboratory worksheet

### Assessment Type

Practical Assessment

### Task Description

You are going to conduct three labs, namely Free vibration, Forced vibration, and Mass balance. After conducting these labs, you will complete each task given in the lab worksheet template. You don't need to give lengthy answers for the discussion tasks. You must show all workings where applicable. You must cite the sources of your argument and discussions as per the referencing style specified in the unit profile. This lab worksheet must NOT exceed 15 pages. You will submit it to the submission link provided in Moodle.

**Assessment Due Date**

Week 12 Friday (31 May 2024) 11:59 pm AEST

**Return Date to Students**

Review/Exam Week Friday (7 June 2024)

Students to see feedback through the submission link

**Weighting**

15%

**Minimum mark or grade**

40% of allocated marks for this assessment

**Assessment Criteria**

Each of the tasks given in the lab worksheet template will be assessed by

- Accurate results
- Accurate plots with correct axis titles and legends
- Appropriate discussions with supporting references

**Referencing Style**

- [Harvard \(author-date\)](#)

**Submission**

Online

**Submission Instructions**

Submission to be made through a link provided in unit's Moodle site

**Learning Outcomes Assessed**

- Communicate professionally using relevant technical terminology, symbols, and diagrams and effectively document calculations and solutions
- Work autonomously and as a team member to analyse problems and present solutions.

## 5 Final report for Design of a walking mechanism with minimum imbalance and vibration

**Assessment Type**

Portfolio

**Task Description**

Your final report will include Tasks 1 and 2 with further improvement from your interim report.

**Task 3:** Conduct vibration analysis of your design

**Task 4:** Verification of your analysis and Evaluation of your design

**Assessment Due Date**

Exam Week Monday (10 June 2024) 11:59 pm AEST

**Return Date to Students**

Exam Week Friday (14 June 2024)

Students to see feedback through the submission link

**Weighting**

30%

**Minimum mark or grade**

50% of allocated marks for this assessment

**Assessment Criteria**

The following criteria will be used to grade your report. This is not the suggested structure of your report.

- Innovation and creativity (/20%)
- Presentation (/20%)
- Introduction and background (/15%)
- Methods and results (/20%)
- Discussion (/15%)
- Conclusions (/10%)

**Referencing Style**

- [Harvard \(author-date\)](#)

## Submission

Online

## Submission Instructions

Submission to be made through a link provided in unit's Moodle site

## Learning Outcomes Assessed

- Apply concepts of dynamics in balancing of rotating components
- Analyse vibrations in single and multiple degree of freedom systems
- Communicate professionally using relevant technical terminology, symbols, and diagrams and effectively document calculations and solutions
- Work autonomously and as a team member to analyse problems and present solutions.

## 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