UNSW Course Outline

ZEIT3502 Vibration and Control Engineering - 2024

Published on the 13 Feb 2024

General Course Information

Course Code : ZEIT3502
Year : 2024
Term : Semester 1
Teaching Period : Z1
Is a multi-term course? : No
Faculty : UNSW Canberra
Academic Unit : School of Engineering and Technology
Delivery Mode : In Person
Delivery Format : Standard
Delivery Location : UNSW Canberra at ADFA
Campus : UNSW Canberra
Study Level : Undergraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

This course provides a foundation in modelling dynamics of engineering systems and leads to solution of practical problems in vibration and automatic control. Free body diagrams and energy methods will be shown. Solution of free and forced response will be investigated. Basic vibration

analysis will be used to apply vibration isolation methods. Multiple degree of freedom systems including lumped parameter systems will be introduced leading to the eigenvalue problem and modal analysis. The course will enable students to analyse and design effective feedback control using a broad range of control design tools including mathematical modelling of system components, block diagram manipulation, linearisation, Laplace transform and root locus. Students will study practical controllers such as the PID controller.

The course builds upon the knowledge from the earlier course on dynamics along with mathematics.

Course Aims

This course aim to provide students with the foundation in modelling the dynamics of engineering systems and leads to the solution of practical problems in vibration and automatic control.

Relationship to Other Courses

Prerequisites: ZPEM2309 and ZPEM2310

The mathematical knowledge required in this course comes fom Calculus. Complex numbers, Laplace transforms and solution to second order ODEs are essential to successfully follow this course. Concepts from this course will lead unto the design courses as well as to the final year thesis.

Course Learning Outcomes

Course Learning Outcomes	Engineers Australia - Professional Engineer (Stage 1)
CLO1 : On successful completion of this program, the student will be able to analyse dynamical systems and represent them through differential equations	• PEE1.1 : Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline • PEE1.2 : Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline
CLO2 : On successful completion of this program, the student will be able to convert models among differential equations and transfer functions	• PEE1.2 : Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline • PEE1.3 : In-depth understanding of specialist bodies of knowledge within the engineering discipline
CLO3 : On successful completion of this program, the student will be able to apply techniques to obtain dynamic system model parameters	• PEE1.3 : In-depth understanding of specialist bodies of knowledge within the engineering discipline • PEE2.1 : Application of established engineering methods to complex engineering problem solving • PEE2.2 : Fluent application of engineering techniques, tools and resources
CLO4 : On successful completion of this program, the student will be able to review and improve the response of the system using simple feedback controllers.	• PEE1.3 : In-depth understanding of specialist bodies of knowledge within the engineering discipline • PEE2.1 : Application of established engineering methods to complex engineering problem solving • PEE2.2 : Fluent application of engineering techniques, tools and resources

Course Learning Outcomes	Assessment Item
CLO1 : On successful completion of this program, the student will be able to analyse dynamical systems and represent them through differential equations	• Class Test x 2 • Final Examination • Assignment • Quizzes
CLO2 : On successful completion of this program, the student will be able to convert models among differential equations and transfer functions	• Class Test x 2 • Final Examination • Quizzes
CLO3 : On successful completion of this program, the student will be able to apply techniques to obtain dynamic system model parameters	• Assignment • Class Test x 2 • Final Examination
CLO4 : On successful completion of this program, the student will be able to review and improve the response of the system using simple feedback controllers.	• Assignment • Quizzes • Class Test x 2 • Final Examination

Learning and Teaching Technologies

Moodle - Learning Management System

Learning and Teaching in this course

The course aims to develop the fundamentals of vibrations and control of dynamic systems. This course builds on the knowledge from the Dynamics and Mathematics.

The course is deliberately broken down into two components. The first component involves the development of the basics related to vibration of mechanical systems, a necessary component for Mechanical Engineers. In this, mathematical modelling of dynamic systems and their analysis is presented. This includes both frequency and time responses under excitation. Introduction to two-degree freedom system is included as generalisation to multi-degree freedom systems. The second component builds on this and uses the basics of feedback to improve the dynamics of systems. The concepts of linear systems, their advantages, alternate modelling to differential equations using Laplace transformation is covered. Basics of stability and time response as related to transfer functions (poles) is provided to show the advantages of the transfer function approach. The necessity and effect of feedback is developed using simple spring-mass-dampers. Analysis and design using root-locus technique is taken up to improve the dynamics of linear systems.

Numerical examples to emphasise the theoretical concepts will be provided during the lecture.

The Learning Management System

Moodle is the Learning Management System used at UNSW Canberra. All courses have a Moodle site which will become available to students at least one week before the start of semester. Please find all help and documentation (including Blackboard Collaborate) at the Moodle Support page.

UNSW Moodle supports the following web browsers:

» Google Chrome 50+
» Safari 10+
** Internet Explorer is not recommended

** Addons and Toolbars can affect any browser's performance.

Operating systems recommended are:

Windows 7, 10, Mac OSX Sierra, iPad IOS10

For further details about system requirements click here.

Log in to Moodle here.

If you need further assistance with Moodle:

For enrolment and login issues please contact:
IT Service Centre
Email: itservicecentre@unsw.edu.au
Phone: (02) 9385-1333
International: +61 2 9385 1333

For all other Moodle issues please contact:
External TELT Support
Email: externalteltsupport@unsw.edu.au
Phone: (02) 9385-3331
International: +61 2 938 53331

Opening hours:
Monday – Friday 7:30am – 9:30 pm
Saturday & Sunday 8:30 am – 4:30pm

Other Professional Outcomes

This course contributes to the following Program Learning Outcomes of the Bachelor of Engineering (Hons) (Mechanical Engineering)

PLO1: Students will be able to relate a quantitative, theory-based understanding of the sciences and engineering fundamentals of mechanical engineering (encompassing design, manufacture, kinematic, aerodynamic, thermal, and structural analysis, and instrumentation and control of mechanical systems).

PLO2: Students will be able to appropriately select and apply the mathematical, statistical, programming and computational tools, and techniques which underpin mechanical engineering.

PLO3: Students will demonstrate a comprehensive understanding of mechanical systems and sub-systems, and articulate directions of future research and knowledge development in mechanical engineering.

PLO4: Students will synthesise engineering design practice, contextual factors, norms and accountabilities in and the limitations on mechanical engineering.

PLO5: Students will define, conduct experiments on and analyse complex, open-ended problems and apply appropriate methods for their solution.

PLO6: Students will demonstrate proficiency in applying systematic engineering synthesis and design processes, and critically evaluating and effectively communicating the results and implications to all audiences.

PLO8: Students will demonstrate independence, creativity and ethical conduct, and explain the importance of user-focused and sustainable solutions.

Additional Course Information

Study at UNSW Canberra

https://www.unsw.adfa.edu.au/study

Study at UNSW Canberra has lots of useful information regarding:

- Where to get help
- Administrative matters
- Getting your passwords set up

- How to log on to Moodle
- Accessing the Library and other areas.

Referencing

In this course, students are required to reference following the APA 7 referencing style.

Information about referencing styles is available at: https://guides.lib.unsw.adfa.edu.au/c.php?g=472948&p=3246720

CRICOS Provider no. 00098G

The University of New South Wales Canberra.

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates	Engineers Australia - Professional Engineer (Stage 1)
Class Test x 2 Assessment Format: Individual	25%	Start Date: Test 1: 5 April 2024, Test 2: 31 May 2024 Due Date: Not Applicable	• PEE2.1 : Application of established engineering methods to complex engineering problem solving • PEE2.2 : Fluent application of engineering techniques, tools and resources • PEE2.3 : Application of systematic engineering synthesis and design processes
Final Examination Assessment Format: Individual	50%	Start Date: Exam week Due Date: Exam week	• PEE2.1 : Application of established engineering methods to complex engineering problem solving • PEE2.2 : Fluent application of engineering techniques, tools and resources • PEE2.3 : Application of systematic engineering synthesis and design processes • PEE2.4 : Application of systematic approaches to the conduct and management of projects within the technology domain
Assignment Assessment Format: Individual	10%	Start Date: 28/03/2024 06:00 PM Due Date: 03/05/2024 11:59 PM	• PEE1.1 : Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline • PEE1.2 : Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline • PEE2.1 : Application of established engineering methods to complex

			engineering problem solving • PEE2.3 : Application of systematic engineering synthesis and design processes
Quizzes Assessment Format: Individual	15%	Start Date: 29/02/2024 04:00 PM Due Date: on the day	• PEE1.1 : Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline • PEE1.2 : Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline • PEE2.1 : Application of established engineering methods to complex engineering problem solving • PEE2.3 : Application of systematic engineering synthesis and design processes

Assessment Details

Class Test x 2

Assessment Overview

These tests include questions to evaluate the conceptual understanding of the course material and numerical problems as applications of the process. Brief answers are expected for the questions.

The solutions of the tests are discussed in the class and the same is also put in MOODLE. Briefly 'why' and 'how' of the markings are provided in the marked test papers.

Course Learning Outcomes

- CLO1 : On successful completion of this program, the student will be able to analyse dynamical systems and represent them through differential equations
- CLO2 : On successful completion of this program, the student will be able to convert models among differential equations and transfer functions
- CLO3 : On successful completion of this program, the student will be able to apply techniques to obtain dynamic system model parameters

- CLO4 : On successful completion of this program, the student will be able to review and improve the response of the system using simple feedback controllers.

Detailed Assessment Description

There will be two class tests, one for the vibration component (10%) at the end of week 6, and one for the control component (15%) at the end of week 12.

Assessment Length

1 hour each

Submission notes

Class test, written test.

Assignment submission Turnitin type

Not Applicable

Final Examination

Assessment Overview

This will cover the entire course learnings and will be similar in format to the class tests. It will have both conceptual questions and numerical problems. Brief answers are expected for the conceptual questions.

Course Learning Outcomes

- CLO1 : On successful completion of this program, the student will be able to analyse dynamical systems and represent them through differential equations
- CLO2 : On successful completion of this program, the student will be able to convert models among differential equations and transfer functions
- CLO3 : On successful completion of this program, the student will be able to apply techniques to obtain dynamic system model parameters
- CLO4 : On successful completion of this program, the student will be able to review and improve the response of the system using simple feedback controllers.

Detailed Assessment Description

The final exam will cover 50/50 the vibration and control topics.

Assessment Length

3 hours

Submission notes

Invigilated exam

Assignment submission Turnitin type

Not Applicable

Assignment

Assessment Overview

n/a

Course Learning Outcomes

- CLO1 : On successful completion of this program, the student will be able to analyse dynamical systems and represent them through differential equations
- CLO3 : On successful completion of this program, the student will be able to apply techniques to obtain dynamic system model parameters
- CLO4 : On successful completion of this program, the student will be able to review and improve the response of the system using simple feedback controllers.

Detailed Assessment Description

This assigment covers the numerical aspects of the vibration component of this course.

Submission notes

Moodle

Assignment submission Turnitin type

Not Applicable

Quizzes

Assessment Overview

These are simple numerical and/or multi-choice quizzes to keep up with the understanding of the course. These are conducted in the class and the solutions are discussed in the class.

Course Learning Outcomes

- CLO1 : On successful completion of this program, the student will be able to analyse dynamical systems and represent them through differential equations
- CLO2 : On successful completion of this program, the student will be able to convert models among differential equations and transfer functions
- CLO4 : On successful completion of this program, the student will be able to review and improve the response of the system using simple feedback controllers.

Detailed Assessment Description

There will be equally weighted weekly quizzes to encourage the students to keep up to date with the vibration part of the course, worth 5% in total. These quizzes will be conducted on the first

half of the weekly lab hour, precluding the neccesity to spend time studying for it.

The equally weighted control quizzes, worth 10% in total, will be conducted during the tutorial hour.

The total of vibration and control quizzes is worth 15% of the total marks for this course.

Assessment Length

20 mins weekly

Assignment submission Turnitin type

Not Applicable

General Assessment Information

Class quizzes 1 and 2 will have been held by week 2, grades and worked solutions will be given to students by week 3.

Late submission of assessment

Unless prior arrangement is made with the lecturer or a formal application for special consideration is submitted, a penalty of 5% of the total available mark for the assessment will apply for each day that an assessment item is late up to a maximum of 5 days (120 hours) after which an assessment can no longer be submitted and a grade of 0 will be applied.

Use of Generative AI

It is prohibited to use any software or service to search for or generate information or answers. If its use is detected, it will be regarded as serious academic misconduct and subject to the standard penalties, which may include 00FL, suspension and exclusion.

Grading Basis

Standard

Requirements to pass course

50% of overall assessments.

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 26 February - 1 March	Lecture	Intro to vibrations, Simple Harmonic Motion, Vibration of Undamped Systems
Week 2 : 4 March - 8 March	Lecture	Free Vibrations with Viscous Damping, Modeling and energy methods
Week 3 : 11 March - 15 March	Lecture	More on Stiffness, Measurement, Design Considerations, Stability
Week 4 : 18 March - 22 March	Lecture	Numerical Simulation of Time Response, Coulomb Friction and the Pendulum
Week 5 : 25 March - 29 March	Lecture	Harmonic Excitation of Undamped Systems, Harmonic Excitation of Damped Systems
Week 6 : 1 April - 5 April	Lecture	Base Excitation and Transmissibility
	Assessment	Vibration class test, 1 hr duration.
Week 7 : 22 April - 26 April	Lecture	Linear Systems and their properties.
Week 8 : 29 April - 3 May	Lecture	Transfer Functions, Poles and Zeros, Stability.
Week 9 : 6 May - 10 May	Lecture	Time Response.
Week 10 : 13 May - 17 May	Lecture	Time Response.
Week 11 : 20 May - 24 May	Lecture	Root Locus.
Week 12 : 27 May - 31 May	Lecture	Root Locus Design and PID controllers.
	Assessment	Class test 2
Week 13 : 3 June - 7 June	Lecture	Revision.

Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

General Schedule Information

Lectures:

Wednesdays: 14.00 - 16.00, LTS01

Thursdays: 14.00 - 16.00, LTN06

Labs/quizzes:

Thursdays: 16.00 - 18.00, SR04

Tutorials:

Fridays: 16.00 - 18.00, SL03

Assignment due date: 03/05/2024 midnight.

Missed classes:

- 29/3/2024 Good Friday
- 24/4/2024 Military Training Day
- 25/4/2024 ANZAC Day Holiday
- 10/5/2024 Military Training Day

Course Resources

Prescribed Resources

Prescribed text for Vibrations:

- Daniel J. Inman, *Engineering Vibration*, 4rd Edition, Prentice Hall, 2014.

Prescribed text for Control:

- Katsuhiko Ogata, *Modern Control Engineering*, Prentice Hall.

Course Evaluation and Development

We constantly feed back in previous year's comments where appropriate.

One of the key priorities in the 2025 Strategy for UNSW is a drive for academic excellence in education. One of the ways of determining how well UNSW is progressing towards this goal is by listening to our own students. Students will be asked to complete the myExperience survey towards the end of this course.

Students can also provide feedback during the semester via: direct contact with the lecturer, the “On-going Student Feedback” link in Moodle, Student-Staff Liaison Committee meetings in schools, informal feedback conducted by staff, and focus groups. Student opinions really do make a difference. Refer to the Moodle site for this course to see how the feedback from previous students has contributed to the course development.

Important note: Students are reminded that any feedback provided should be constructive and professional and that they are bound by the Student Code of Conduct Policy

https://www.gs.unsw.edu.au/policy/documents/studentcodepolicy.pdf

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Murat Taht ali		Bld17-R204	02 5114 5210	Appointment by Teams	No	Yes
Lecturer	Sreenatha Anavatti		Bld17-R203		Appointment by Teams	No	No
	Yan Kei Chiang		Building 16, room 226	02 5114 5335	Yan Kei is usually available for consultation between 1030 and 1530 Tuesday to Friday, either in person or on Teams. Please email to make an appointment.	No	No

Other Useful Information

Academic Information

Course Evaluation and Development

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Students can also provide feedback during the semester via: direct contact with the lecturer, the "On-going Student Feedback" link in Moodle, Student-Staff Liaison Committee meetings in schools, informal feedback conducted by staff, and focus groups (where applicable). Student opinions really do make a difference. Refer to the Moodle site for your course to see how the feedback from previous students has contributed to the course development.

Important note: Students are reminded that any feedback provided should be constructive and professional and that they are bound by the Student Code of Conduct.

https://www.gs.unsw.edu.au/policy/documents/studentcodepolicy.pdf

Equitable Learning Services (ELS)

Students living with neurodivergent, physical and/or mental health conditions or caring for someone with these conditions may be eligible for support through the Equitible Learning Services team. Equitable Learning Services is a free and confidential service that provides practical support to ensure your mental or physical health conditions do not adversely affect your studies.

Our team of dedicated **Equitable Learning Facilitators** (ELFs) are here to assist you through this process. We offer a number of services to make your education at UNSW easier and more equitable.

Further information about ELS for currently enrolled students can be found at: https://www.student.unsw.edu.au/equitable-learning

Academic Honesty and Plagarism

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW staff and students have a responsibility to adhere to this principle of academic integrity. All students are expected to adhere to UNSW's Student Code of Conduct. Find relevant information at: Student Code of Conduct (unsw.edu.au)

Plagiarism undermines academic integrity and is not tolerated at UNSW. It is defined as using the words or ideas of others and passing them off as your own, and can take many forms, from deliberate cheating to accidental copying from a source without acknowledgement.

For more information, please refer to the following:

https://student.unsw.edu.au/plagiarism

Submission of Assessment Tasks

Special Consideration

Special Consideration is the process for assessing and addressing the impact on students of short-term events, that are beyond the control of the student, and that affect performance in a specific assessment task or tasks.

Applications for Special Consideration will be accepted in the following circumstances only:

- Where academic work has been hampered to a substantial degree by illness or other cause;
- The circumstances are unexpected and beyond the student's control;
- The circumstances could not have reasonably been anticipated, avoided or guarded against by the student; and either:

(i) they occurred during a critical study period and was 3 consecutive days or more duration, or a total of 5 days within the critical study period; or

(ii) they prevented the ability to complete, attend or submit an assessment task for a specific date (e.g. final exam, in class test/quiz, in class presentation)

Applications for Special Consideration must be made as soon as practicable after the problem occurs and at the latest within three working days of the assessment or the period covered by the supporting documentation.

By sitting or submitting the assessment task the student is declaring that they are fit to do so and cannot later apply for Special Consideration (UNSW 'fit to sit or submit' requirement).

Sitting, accessing or submitting an assessment task on the scheduled assessment date, after applying for special consideration, renders the special consideration application void.

Find more information about special consideration at: https://www.student.unsw.edu.au/special/consideration/guide

Or apply for special consideration through your MyUNSW portal.

Late Submission of assessment tasks (other than examinations)

UNSW has a standard late submission penalty of:

- 5% per day,
- capped at five days (120 hours) from the assessment deadline, after which a student cannot submit an assessment, and
- no permitted variation.

Students are expected to manage their time to meet deadlines and to request extensions as early as possible before the deadline.

Electronic submission of assessment

Except where the nature of an assessment task precludes its electronic submission, all assessments must be submitted to an electronic repository, approved by UNSW or the Faculty, for archiving and subsequent marking and analysis.

Release of final mark

All marks obtained for assessment items during the session are provisional. The final mark as published by the university following the assessment review group meeting is the only official mark.