UNSW Course Outline

MECH4305 Fundamental and Advanced Vibration Analysis - 2024

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General Course Information

Course Code : MECH4305
Year : 2024
Term : Term 3
Teaching Period : T3
Is a multi-term course? : No
Faculty : Faculty of Engineering
Academic Unit : School of Mechanical and Manufacturing Engineering
Delivery Mode : In Person
Delivery Format : Standard
Delivery Location : Kensington
Campus : Sydney
Study Level : Postgraduate, Undergraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

Typically, vibration is undesirable. It can lead to excessive deflections and the failure of machines and structures. But vibration can also be useful. We can use vibration content as an indicator of a machine's condition or to diagnosis its faults. This course will help you to understand,

measure, make accurate predictions, and communicate about the world around you through the lens of vibration analysis. Almost every machine and structure you will ever encounter produces vibration. By the end of this course, you will be able to measure and predict the vibratory response of real-world engineering systems and use this information to control or harness the power of vibration.

This course builds upon the acquired knowledge of an introductory course in vibrations (such as MMAN2300) where you will have studied oscillatory systems under a number of simplifying assumptions – sinusoidal forcing, constant coefficients, simple boundary conditions, etc. In this course, you will examine more complex systems and excitations. As such, you will be exposed to new techniques for modelling, measuring and analysing oscillatory systems. The analytical and computational tools you will develop in this course will be applied to the challenging and critical application of machine condition monitoring. Vibration-based condition monitoring is a large and expanding field of engineering research and application, which allows massive safety improvements and economic advantages in almost every industry.

Course Aims

This course aims to develop your understanding of the analysis and design of dynamic mechanical systems.

This course builds upon foundational knowledge introduced in your engineering mechanics or introductory mechanical vibration courses. It will cover free and forced responses of single degree-of-freedom (SDOF) systems; analysis of continuous systems, longitudinal/torsional vibration of bars and rods, bending vibration of beams; vibration measurement instruments; typical sources of vibration in machines and vibration testing and signal processing techniques. We will examine how these topics relate to our everyday lives and are linked with many facets of engineering.

It is expected that upon completion of this course, students should be prepared to take on a thesis project, or pursue a career, in vibration analysis and engineering.

Relationship to Other Courses

The following assumed knowledge is expected for students undertaking this course: MATH2019 and MMAN2300.

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Determine the vibratory response of a SDOF system to harmonic, periodic and non-periodic excitation.
CLO2 : Predict and describe the equilibrium or vibratory motion of a continuous system.
CLO3 : Program signal processing tools to analyse vibration measurements and extract fault symptoms in rotating machines.
CLO4 : Produce appropriate reports to communicate about technical matters relating to vibration at a professional engineering level.

Course Learning Outcomes	Assessment Item
CLO1 : Determine the vibratory response of a SDOF system to harmonic, periodic and non-periodic excitation.	• Problem set 1: Fourier analysis and convolution • Problem set 2: Free and forced response of beams and Hamilton's Principle • Problem set 3: Vibration measurements and signal analysis • Final Examination
CLO2 : Predict and describe the equilibrium or vibratory motion of a continuous system.	• Problem set 1: Fourier analysis and convolution • Problem set 2: Free and forced response of beams and Hamilton's Principle • Problem set 3: Vibration measurements and signal analysis • Final Examination
CLO3 : Program signal processing tools to analyse vibration measurements and extract fault symptoms in rotating machines.	• Problem set 3: Vibration measurements and signal analysis • Final Examination
CLO4 : Produce appropriate reports to communicate about technical matters relating to vibration at a professional engineering level.	• Problem set 1: Fourier analysis and convolution • Problem set 2: Free and forced response of beams and Hamilton's Principle • Problem set 3: Vibration measurements and signal analysis

Learning and Teaching Technologies

Moodle - Learning Management System | Microsoft Teams | Echo 360

Other Professional Outcomes

https://www.unsw.edu.au/engineering/student-life/student-resources/program-design

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Problem set 1: Fourier analysis and convolution Assessment Format: Individual	20%	Start Date: Not Applicable Due Date: 27/09/2024 05:00 PM Post Date: 11/10/2024 05:00 PM
Problem set 2: Free and forced response of beams and Hamilton's Principle Assessment Format: Individual	20%	Start Date: Not Applicable Due Date: 21/10/2024 05:00 PM Post Date: 04/11/2024 05:00 PM
Problem set 3: Vibration measurements and signal analysis Assessment Format: Individual	20%	Start Date: Not Applicable Due Date: 15/11/2024 05:00 PM Post Date: 29/11/2024 05:00 PM
Final Examination Assessment Format: Individual	40%	Start Date: Not Applicable Due Date: Not Applicable

Assessment Details

Problem set 1: Fourier analysis and convolution

Assessment Overview

This is an individual assignment approx. 15 pages in length. Marking will be against specific assessment criteria. Individual written feedback will be provided online.

Course Learning Outcomes

- CLO1 : Determine the vibratory response of a SDOF system to harmonic, periodic and non-periodic excitation.
- CLO2 : Predict and describe the equilibrium or vibratory motion of a continuous system.
- CLO4 : Produce appropriate reports to communicate about technical matters relating to vibration at a professional engineering level.

Detailed Assessment Description

This assignment will require you to solve a series of analytical SDOF vibration problems with complex forcing. You will use MATLAB to plot and examine the system response.

Assessment Length

Approx. 15 pages including full working

Submission notes

Submit your assignment using the template provided on the course Moodle page.

Assignment submission Turnitin type

This assignment is submitted through Turnitin and students do not see Turnitin similarity reports.

Generative AI Permission Level

No Assistance

This assessment is designed for you to complete without the use of any generative AI. You are not permitted to use any generative AI tools, software or service to search for or generate information or answers.
For more information on Generative AI and permitted use please see here.

Problem set 2: Free and forced response of beams and Hamilton's Principle

Assessment Overview

This is an individual assignment approx. 15 pages in length. Marking will be against specific assessment criteria. Individual written feedback will be provided online.

Course Learning Outcomes

- CLO1 : Determine the vibratory response of a SDOF system to harmonic, periodic and non-periodic excitation.
- CLO2 : Predict and describe the equilibrium or vibratory motion of a continuous system.
- CLO4 : Produce appropriate reports to communicate about technical matters relating to vibration at a professional engineering level.

Detailed Assessment Description

This assignment will require you to solve a series of analytical vibration problems relevant to contiunous systems. You will use MATLAB to plot and examine the system response.

Assessment Length

Approx. 15 pages including full working

Submission notes

Submit your assignment using the template provided on the course Moodle page.

Assignment submission Turnitin type

This assignment is submitted through Turnitin and students do not see Turnitin similarity reports.

Generative AI Permission Level

No Assistance

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Problem set 3: Vibration measurements and signal analysis

Assessment Overview

This is an individual assignment approx. 15 pages in length. Marking will be against specific assessment criteria. Individual written feedback will be provided online.

Course Learning Outcomes

- CLO1 : Determine the vibratory response of a SDOF system to harmonic, periodic and non-periodic excitation.
- CLO2 : Predict and describe the equilibrium or vibratory motion of a continuous system.
- CLO3 : Program signal processing tools to analyse vibration measurements and extract fault symptoms in rotating machines.
- CLO4 : Produce appropriate reports to communicate about technical matters relating to vibration at a professional engineering level.

Detailed Assessment Description

This assignment will require you to analyse real vibration measurements using the signal processing tools introduced in class.

Assessment Length

Approx. 15 pages including full working.

Submission notes

Submit your assignment using the template provided on the course Moodle page.

Assignment submission Turnitin type

This assignment is submitted through Turnitin and students do not see Turnitin similarity reports.

Generative AI Permission Level

No Assistance

This assessment is designed for you to complete without the use of any generative AI. You are not permitted to use any generative AI tools, software or service to search for or generate information or answers.
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Final Examination

Assessment Overview

This is a 2-hour individual open book exam. The exam assesses all course material. Marking will be against specific assessment criteria.

Course Learning Outcomes

- CLO1 : Determine the vibratory response of a SDOF system to harmonic, periodic and non-periodic excitation.
- CLO2 : Predict and describe the equilibrium or vibratory motion of a continuous system.
- CLO3 : Program signal processing tools to analyse vibration measurements and extract fault symptoms in rotating machines.

Detailed Assessment Description

This exam assess all course content and is an oppourtunity to show your achievement of Learning Outcomes 1-3.

Assessment Length

2 hour open book exam.

Assignment submission Turnitin type

Not Applicable

Generative AI Permission Level

No Assistance

This assessment is designed for you to complete without the use of any generative AI. You are not permitted to use any generative AI tools, software or service to search for or generate information or answers.
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General Assessment Information

Re-weighting is not an option for the school.

Grading Basis

Standard

Requirements to pass course

Students must achieve a composite mark of at least 50 out of 100.

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 9 September - 15 September	Lecture	• Introduction and review of fundamentals • Fourier analysis for a SDOF system with a periodic force
	Workshop	Problem Solving Class: • Introduction to MATLAB
Week 2 : 16 September - 22 September	Lecture	• Convolution for a SDOF system with a non-periodic force
	Workshop	Problem Solving Class: • Fourier analysis and convolution
Week 3 : 23 September - 29 September	Lecture	• Free vibration of beams in flexure
	Workshop	Problem Solving Class: • Free vibration of beams in flexure
Week 4 : 30 September - 6 October	Lecture	• Forced response of beams
	Workshop	Problem Solving Class: • Forced response of beams
Week 5 : 7 October - 13 October	Lecture	• Hamilton's Principle and Lagrange's Equations
	Workshop	Problem Solving Class: • Hamilton's Principle and Lagrange's Equations
Week 6 : 14 October - 20 October	Other	Flexibility Week
Week 7 : 21 October - 27 October	Lecture	• Measuring vibration: transducers and data acquistion • Vibration signal processing
	Workshop	Problem Solving Class: • Vibration signal processing
Week 8 : 28 October - 3 November	Lecture	• Vibration guidelines and standards • Human response to vibration
	Workshop	Problem Solving Class: • Guidelines, standards and human response to vibration
Week 9 : 4 November - 10 November	Lecture	• Vibration guest lecture
	Workshop	Problem Solving Class: • Vibration live demonstration
Week 10 : 11 November - 17 November	Lecture	• Exam preparation and revision
	Workshop	Problem Solving Class: • Exam preparation and revision

Attendance Requirements

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

Course Resources

Prescribed Resources

The textbook for this course is:

- Rao, S.S. Mechanical Vibrations, 6th Edition in SI Units, Pearson
  - Print: https://www.bookshop.unsw.edu.au/details.cgi?ITEMNO=9781292178608
  - Digital: Mechanical Vibrations, in SI Units 6th edition | 9781292178608, 9781292178615 | University of New South Wales (vitalsource.com)

The relevant chapters are stated on the course Moodle page in each week folder and in the

lecture notes.

The software used in this course is:

- MATLAB

UNSW has a MATLAB site license that allows currently enrolled UNSW students to download and install MATLAB on their own laptop or home PC. Further details of the license conditions and for download and installation instructions see the UNSW IT > IT For Students > Software > Matlab page.

Course materials (lecture notes and problem solving exercises) will be provided on the course Moodle page.

Recommended Resources

There are also several recommended books that are closely related to the course content. Many of these books are available through the library:

- Meirovitch, L. Fundamentals of Vibrations, 1st Edition, Waveland Press
- Bendat and Piersol, Random Data: Analysis and Measurement Procedures, 2010, John Wiley and Sons
- Randall, R., Vibration-based Condition Monitoring: Industrial, Aerospace and Automotive Applications, 2010, John Wiley and Sons

UNSW Library website: https://www.library.unsw.edu.au/

Moodle: https://moodle.telt.unsw.edu.au/login/index.php

Course Evaluation and Development

Feedback on the course is gathered periodically using various means, including the UNSW myExperience process, informal discussion in the final class for the course, and the School's Student/Staff meetings. Your feedback is taken seriously, and continual improvements are made to the course based, in part, on such feedback.

In this course, recent improvements resulting from student feedback include providing more worked examples with full MATLAB code on the course Moodle page and in class during lectures.

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Danielle Moreau		Ainsworth Building (J17), Level 4, Room 408E	(02) 9385 5428	Please contact Danielle by email to arrange an appointment outside of scheduled teaching times.	No	Yes

Other Useful Information

Academic Information

I. Special consideration and supplementary assessment

If you have experienced an illness or misadventure beyond your control that will interfere with your assessment performance, you are eligible to apply for Special Consideration prior to, or within 3 working days of, submitting an assessment or sitting an exam.

Please note that UNSW has a Fit to Sit rule, which means that if you sit an exam, you are declaring yourself fit enough to do so and cannot later apply for Special Consideration.

For details of applying for Special Consideration and conditions for the award of supplementary assessment, please see the information on UNSW's Special Consideration page.

II. Administrative matters and links

All students are expected to read and be familiar with UNSW guidelines and polices. In particular, students should be familiar with the following:

- Attendance
- UNSW Email Address
- Special Consideration
- Exams
- Approved Calculators
- Academic Honesty and Plagiarism
- Equitable Learning Services

III. Equity and diversity

Those students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course convener prior to, or at

the commencement of, their course, or with the Equity Officer (Disability) in the Equitable Learning Services. Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.

IV. Professional Outcomes and Program Design

Students are able to review the relevant professional outcomes and program designs for their streams by going to the following link: https://www.unsw.edu.au/engineering/student-life/student-resources/program-design.

Note: This course outline sets out the description of classes at the date the Course Outline is published. The nature of classes may change during the Term after the Course Outline is published. Moodle or your primary learning management system (LMS) should be consulted for the up-to-date class descriptions. If there is any inconsistency in the description of activities between the University timetable and the Course Outline/Moodle/LMS, the description in the Course Outline/Moodle/LMS applies.

Academic Honesty and Plagarism

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW students have a responsibility to adhere to this principle of academic integrity. Plagiarism undermines academic integrity and is not tolerated at UNSW. *Plagiarism at UNSW is defined as using the words or ideas of others and passing them off as your own.*

Plagiarism is a type of intellectual theft. It can take many forms, from deliberate cheating to accidentally copying from a source without acknowledgement. UNSW has produced a website with a wealth of resources to support students to understand and avoid plagiarism, visit: student.unsw.edu.au/plagiarism. The Learning Centre assists students with understanding academic integrity and how not to plagiarise. They also hold workshops and can help students one-on-one.

You are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting and the proper referencing of sources in preparing all assessment tasks.

Repeated plagiarism (even in first year), plagiarism after first year, or serious instances, may also

be investigated under the Student Misconduct Procedures. The penalties under the procedures can include a reduction in marks, failing a course or for the most serious matters (like plagiarism in an honours thesis or contract cheating) even suspension from the university. The Student Misconduct Procedures are available here:

www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf

Submission of Assessment Tasks

Work submitted late without an approved extension by the course coordinator or delegated authority is subject to a late penalty of five percent (5%) of the maximum mark possible for that assessment item, per calendar day.

The late penalty is applied per calendar day (including weekends and public holidays) that the assessment is overdue. There is no pro-rata of the late penalty for submissions made part way through a day. This is for all assessments where a penalty applies.

Work submitted after five days (120 hours) will not be accepted and a mark of zero will be awarded for that assessment item.

For some assessment items, a late penalty may not be appropriate. These will be clearly indicated in the course outline, and such assessments will receive a mark of zero if not completed by the specified date. Examples include:

- Weekly online tests or laboratory work worth a small proportion of the subject mark;
- Exams, peer feedback and team evaluation surveys;
- Online quizzes where answers are released to students on completion;
- Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date; and,
- Pass/Fail assessment tasks.

Faculty-specific Information

Engineering Student Support Services – The Nucleus - enrolment, progression checks, clash requests, course issues or program-related queries

Engineering Industrial Training – Industrial training questions

UNSW Study Abroad – study abroad student enquiries (for inbound students)

UNSW Exchange – student exchange enquiries (for inbound students)

UNSW Future Students – potential student enquiries e.g. admissions, fees, programs, credit transfer

Phone

(+61 2) 9385 8500 – Nucleus Student Hub

(+61 2) 9385 7661 – Engineering Industrial Training

(+61 2) 9385 3179 – UNSW Study Abroad and UNSW Exchange (for inbound students)

School-specific Information

Short Extensions

Short extensions are not currently applicable to Mechanical and Manufacturing Engineering Courses.

Review of Results

If you believe that there has been a marking error, you can request a review of results. Review of results cannot be used to get feedback.

If you would like feedback for assessments, you are welcome to contact the course convenor directly.

Use of AI

The use of AI is prohibited unless explicitly permitted by the course convenor. Please respect this and be aware that penalties will apply when unauthorised use is detected, such as through Turnitin. If the use of generative AI, such as ChatGPT, is allowed in a specific assessment, they must be properly credited, and your submissions must be substantially your own work.

Final Exam in Exam Period

For courses with a centrally timetabled final exam, students must be available for the entire exam period from Mon-Sat until your exact exam date is confirmed.

School Contact Information

Location

UNSW Mechanical and Manufacturing Engineering

Ainsworth building J17, Level 1

Above Coffee on Campus

Hours

9:00–5:00pm, Monday–Friday*

*Closed on public holidays, School scheduled events and University Shutdown

Web

School of Mechanical and Manufacturing Engineering

Engineering Student Support Services

Engineering Industrial Training

UNSW Study Abroad and Exchange (for inbound students)

UNSW Future Students

Phone

(+61 2) 9385 8500 – Nucleus Student Hub

(+61 2) 9385 7661 – Engineering Industrial Training

(+61 2) 9385 3179 – UNSW Study Abroad and UNSW Exchange (for inbound students)

(+61 2) 9385 4097 – School Office**

**Please note that the School Office will not know when/if your course convenor is on campus or available

Email

Engineering Student Support Services – current student enquiries

- e.g. enrolment, progression, clash requests, course issues or program-related queries

Engineering Industrial Training – Industrial training questions

UNSW Study Abroad – study abroad student enquiries (for inbound students)

UNSW Exchange – student exchange enquiries (for inbound students)

UNSW Future Students – potential student enquiries

- e.g. admissions, fees, programs, credit transfer

School Office – School general office administration enquiries

- NB: the relevant teams listed above must be contacted for all student enquiries. The School will only be able to refer students on to the relevant team if contacted

Important Links

- Student Wellbeing
- Urgent Mental Health & Support
- Equitable Learning Services
- Faculty Transitional Arrangements for COVID-19
- Moodle
- Lab Access
- Computing Facilities
- Student Resources
- Course Outlines
- Makerspace
- UNSW Timetable
- UNSW Handbook