Never Stand Still   Engineering   Mechanical and Manufacturing Engineering

MECH4305

FUNDAMENTAL AND ADVANCED VIBRATION ANALYSIS

Contents

1. Staff contact details

Contact details and consultation times for course convenor

Name: Dr Danielle Moreau
Office location: Ainsworth Building (J17), Level 4, Room 408E
Tel: (02) 9385 5428
Email: d.moreau@unsw.edu.au

Consultation about course matters will be available in person in Quad G048 on Wednesday from 3pm – 4pm. Other queries and questions can be directed by email or to a relevant Moodle forum.

Contact details for additional lecturers/demonstrators/lab staff

Name: Daniel Eggler
Office location: Ainsworth Building (J17), Level 4, Room 408
Email: d.eggler@unsw.edu.au

Name: Dr Wade Smith
Office location: Ainsworth Building (J17), Level 4, Room 408A
Email: wade.smith@unsw.edu.au

Name: Gyani Sharma
Email: gyanishankar.sharma@unsw.edu.au

Name: Christopher Miller
Email: chrisj.miller1993@gmail.com

Name: Michael Ling
Email: z3463340@student.unsw.edu.au

Name: Deepak Kumar Dalakoti
Email: deepakkdalakoti@gmail.com

2. Course details

Credit Points

This is a 6 unit-of-credit (UoC) course, and involves 3 hours per week (h/w) of face-to-face contact.

The UNSW website states "The normal workload expectations of a student are approximately 25 hours per semester for each UoC, including class contact hours, other learning activities, preparation and time spent on all assessable work. Thus, for a full-time

enrolled student, the normal workload, averaged across the 16 weeks of teaching, study and examination periods, is about 37.5 hours per week."

This means that you should aim to spend about 9 h/w on this course. The additional time should be spent in making sure that you understand the lecture material, completing the set assignments, further reading, and revising for any examinations.

Contact hours

	Day	Time	Location	Week classes begin
Lectures	Tuesday	10am – 11am	Chemical Sc M17	1
	Wednesday	11am – 12pm	Electrical Eng G25	1
Problem Solving Classes	Tuesday	12pm – 1pm	Webster 250 Ainsworth Building G01	2

Summary of the course

This course is a sequel to an introductory course in Vibrations (such as MMAN2300) where you will have studied oscillatory systems under a number of simplifying assumptions – linearity, sinusoidal forcing, constant coefficients, simple boundary conditions, etc. In this course, you will examine systems that are not so nicely behaved. As such, you will be exposed to new techniques for seeing, measuring, thinking about, analysing, designing and controlling oscillatory systems.

Aims of the course

The aim of this course can be stated simply: For everyone involved (staff, students and demonstrators) to progress further towards becoming exceptional engineers. Our field of endeavour will be the concepts and applications of Vibration Analysis. Additionally, we will not measure our progress as the number of equations or facts or theories that we know. Rather we will undertake to measure our degree of transformation into someone who sees, understands, can make relevant and accurate predictions, and communicates about the world around us through the lens of Vibration Analysis.

Student learning outcomes

This course is designed to address the learning outcomes below and the corresponding Engineers Australia Stage 1 Competency Standards for Professional Engineers as shown. The full list of Stage 1 Competency Standards may be found in Appendix A.

After successfully completing this course, you should be able to:

Learning Outcome		EA Stage 1 Competencies
1.	Explain and describe principles and components of Vibration Analysis and their inter-relationships formally and	1.1, 1.2, 1.3 2.2

	informally, in writing and verbally, to technical experts, peers and lay people.	3.2, 3.4
2.	Model, approximate, analyse and simulate vibratory systems that include general forcing, general boundary conditions, and nonlinearities using appropriate computational tools as necessary.	1.1, 1.2, 1.3 2.2
3.	Discern the relevant principles that must be applied to describe or measure the equilibrium or motion of vibratory systems and discriminate between relevant and irrelevant information in the context.	1.1, 1.2, 1.3
4.	Demonstrate an ability to communicate clearly and precisely about technical matters related to Vibration Analysis.	1.2, 1.3 2.1 3.2, 3.4

3. Teaching strategies

This course will be delivered both in the classroom and online. Full participation in the class means that you will participate fully in both arenas. That is, you will be held accountable for all content, instructions, information, etc. that is delivered either in class or online.

Online: The online forum for participation in this class is the Moodle Platform, specifically the MECH4305 course at http://moodle.telt.unsw.edu.au/. All official online interactions will take place or be linked clearly and appropriately from this site.

In class: There are two in-class activities in a typical week which we refer to as the Lecture and Problem Solving Class based on the timetable in Section 2. Both the online and in-class segments of this course are organised on the following principles:

1. **Learning:** Student learning is the first priority - teaching and assessment are secondary concerns. Learning here is defined as gaining new ways of understanding the field of vibration analysis; not as simply memorising information. We are trying to transform you into engineers and critical thinkers in the discipline.
2. **Peer Interaction:** Learning is a social activity, and research shows that you will learn most and best when you are actively taught by your peers and, in turn, when you teach them.
3. **Authenticity:** We will have as much authenticity of engineering practice as is possible within the constraints of the course and where it does not restrain your learning.
4. **High standards:** We will have high standards for achievement in the course, and everyone (including staff) will be accountable for putting in the effort to get you to the standard.
5. **Openness:** As much as possible, this course will be conducted in the open where all participants can be aware of it and comment upon it.
6. **Process:** The focus of the course will be on processes, not outcomes. The right outcomes will be a by-product of following the correct processes.

The lectures in this course will cover core concepts and background theory in Vibration Analysis. The lecture material is available to students electronically before each class via Moodle.

The Problem Solving Classes are designed to provide you with feedback and discussion on the assignments (referred to as Problem Sets). Students are required to work through the Problems Sets during the Problem Solving Class and also during their own personal study time.

4. Course schedule

Note: Problem set is referred to as 'PS' in the following table.

Wk	Date	Lecture Content	Lecture content included in assessment task	Problem Solving Class Content	Assessment due
1	28/02/17	Introduction to the course and a review of fundamental concepts	–	No Problem Solving Class wk 1	
	01/03/17	Fourier Analysis	PS 1, Test 1		
2	07/03/17	Convolution	PS 1, Test 1	PS 1	
	08/03/17	Euler-Bernoulli beams: free response, forced vibrations	PS 1, Test 1		
3	14/03/17	Orthogonality of modes	PS 2, Test 1	PS 1	
	15/03/17	Hamilton's Principle and Lagrange's Equations for continuous systems (part 1)	PS 2, Test 1		
4	21/03/17	Hamilton's Principle and Lagrange's Equations for continuous systems (part 2)	PS 2, Test 1	PS 2	PS 1 due
	22/03/17	Approximation and discretization methods: Rayleigh's Quotient	PS 2, Test 1		
5	28/03/17	Approximation Methods: Rayleigh-Ritz	PS 3, Test 1	PS 2	
	29/03/17	Assumed Modes Method (part 1)	PS 3, Test 1		
6	04/04/17	Assumed Modes Method (part 2)	PS 3, Test 1	PS 3	PS 2 due
	05/04/17	Measuring Vibration: Data acquisition, transducers	PS 4, Test 2		
7	11/04/17	Signal types and classification, errors	PS 4, Test 2	PS 3	

	12/04/17	Signal processing: autocorrelation and frequency domain analysis	PS 4, Test 2		
	Mid-semester break				7
8	25/04/17	No lecture (Anzac Day)	–	No Problem Solving Class (Anzac Day)	Test 1
	26/04/17	Test 1	–		
9	02/05/17	Machine condition monitoring (part 1)	PS 4, Test 2	Problem Set 4	PS 3 due
	03/05/17	Machine condition monitoring (part 2)	PS 4, Test 2		
10	09/05/17	Machine condition monitoring (part 3)	PS 4, Test 2	Problem Set 4	
	10/05/17	Control: Introduction, overview, passive control	PS 5, Test 2		
11	16/05/17	Feedback vs feedforward control	PS 5, Test 2	Problem Set 5	PS 4 due
	17/05/17	AVC, ASAC, DSAS	PS 5, Test 2		
12	23/05/17	Beam control, transfer functions, cost functions	PS 5, Test 2	Problem Set 5	
	24/05/17	Revision	–		
13	30/05/17	No lecture	–	Revision	Test 2 PS 5 due
	31/05/17	Test 2	–		

5. Assessment

Assessment overview

Assessment	Length	Weight	Learning outcomes assessed	Assessment criteria	Due date and submission requirements	Deadline for absolute fail	Marks returned
Problem Sets	5 (as per Section 4)	50%	1,2,3,4	Lecture material from weeks 1 – 12 inclusive	Friday 5pm of week nominated in Section 4 via both Moodle and assignment box	Sunday 5pm following Friday submission	Two weeks after submission
Tests	2 (as per Section 4) of 1 hour each	20%	1,2,3	Lecture material from weeks 1 – 12	During week 8 and 13 Wednesday lectures	N/A	Two weeks after submission
Final exam	2 hours	30%	1,2,3	All course content from weeks 1 – 12 inclusive	Exam period, date TBC	N/A	Upon release of final results

Problem Sets will be placed on the course Moodle page 1 week prior to their discussion in the Problem Solving Class nominated in Section 4. The tests will be provided in class during the week 8 and 13 Wednesday lecture.

Assignments

Presentation

All non-electric submissions should have a standard School cover sheet which is available from this course's Moodle page.

All submissions are expected to be neat and clearly set out. Your results are the pinnacle of all your hard work and should be treated with due respect. Presenting results clearly gives the marker the best chance of understanding your method; even if the numerical results are incorrect.

Submission

Late submissions will be penalised 5 marks per calendar day (including weekends). An extension may only be granted in exceptional circumstances. Where an assessment task is worth less than 20% of the total course mark and you have a compelling reason for being unable to submit your work on time, you must seek approval for an extension from the course convenor **before the due date**. Special consideration for assessment tasks of 20% or greater must be processed through student.unsw.edu.au/special-consideration.

It is always worth submitting late assessment tasks when possible. Completion of the work, even late, may be taken into account in cases of special consideration.

Where there is no special consideration granted, the 'deadline for absolute fail' in the table above indicates the time after which a submitted assignment will not be marked, and will achieve a score of zero for the purpose of determining overall grade in the course.

Marking

Marking guidelines for assignment submissions will be provided at the same time as assignment details to assist with meeting assessable requirements. Submissions will be marked according to the marking guidelines provided.

Examinations

You must be available for all tests and examinations. Final examinations for each course are held during the University examination periods, which are June for Semester 1 and November for Semester 2.

Provisional Examination timetables are generally published on myUNSW in May for Semester 1 and September for Semester 2

For further information on exams, please see the Exams section on the intranet.

Calculators

You will need to provide your own calculator, of a make and model approved by UNSW, for the examinations. The list of approved calculators is shown at student.unsw.edu.au/exam-approved-calculators-and-computers

It is your responsibility to ensure that your calculator is of an approved make and model, and to obtain an "Approved" sticker for it from the School Office or the Engineering Student Centre prior to the examination. Calculators not bearing an "Approved" sticker will not be allowed into the examination room.

Special consideration and supplementary assessment

For details of applying for special consideration and conditions for the award of supplementary assessment, see the School [intranet](#), and the information on UNSW's [Special Consideration page](#).

6. Expected resources for students

Recommended textbook (available through the UNSW bookshop):
    Rao, S.S. Mechanical Vibrations, 5th Edition in SI Units, Pearson

Other suggested books:
    Meirovitch, L. Fundamentals of Vibrations, 1st Edition, Waveland Press
    Meirovitch, L. Principles and Techniques of Vibrations, 1st Edition, Prentice Hall
    Timoshenko, Young, Weaver, Vibration Problems in Engineering, 1975, Wiley
    Thomson & Dahleh, Theory of Vibrations with Applications, 2013, Pearson
    Inman, D.J., Engineering Vibration, 4th Edition, Prentice Hall
    Craig & Kurdila, Fundamentals of Structural Dynamics, 2nd Edition, Wiley
    Strogatz, S.H., Nonlinear Dynamics and Chaos, 2nd Edition, Westview Press
    Den Hartog, J.P., Mechanical Vibration, Dover
    Ewins, D.J., Modal Testing: Theory and Practice, Wiley
    Bendat and Piersol, Random Data: Analysis and Measurement Procedures, 2010, John Wiley and Sons

Moodle site for MECH4305 Access via: http://moodle.telt.unsw.edu.au/

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

7. 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:
- A revision class at the beginning of semester
- More practical lecture content including vibration measurement, machine condition monitoring and vibration control
- Reduced number of problem sets from 6 to 5
- More detailed supplementary information to mathematical content in lecture notes

8. Academic honesty and plagiarism

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: 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.

If plagiarism is found in your work when you are in first year, your lecturer will offer you assistance to improve your academic skills. They may ask you to look at some online resources, attend the Learning Centre, or sometimes resubmit your work with the problem fixed. However more serious instances in first year, such as stealing another student's work or paying someone to do your work, may be investigated under the Student Misconduct Procedures.

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) even suspension from the university. The Student Misconduct Procedures are available here: www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf

Further information on School policy and procedures in the event of plagiarism is available on the intranet.

9. Administrative matters

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

- Attendance, Participation and Class Etiquette
- UNSW Email Address
- Computing Facilities

- [Assessment Matters](#) (including guidelines for assignments, exams and special consideration)
- [Academic Honesty and Plagiarism](#)
- [Student Equity and Disabilities Unit](#)
- [Health and Safety](#)
- [Student Support Services](#)

Danielle Moreau
February 2 2017

Appendix A: Engineers Australia (EA) Competencies

Stage 1 Competencies for Professional Engineers

	Program Intended Learning Outcomes
PE1: Knowledge and Skill Base	PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals
	PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing
	PE1.3 In-depth understanding of specialist bodies of knowledge
	PE1.4 Discernment of knowledge development and research directions
	PE1.5 Knowledge of engineering design practice
	PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice
PE2: Engineering Application Ability	PE2.1 Application of established engineering methods to complex problem solving
	PE2.2 Fluent application of engineering techniques, tools and resources
	PE2.3 Application of systematic engineering synthesis and design processes
	PE2.4 Application of systematic approaches to the conduct and management of engineering projects
PE3: Professional and Personal Attributes	PE3.1 Ethical conduct and professional accountability
	PE3.2 Effective oral and written communication (professional and lay domains)
	PE3.3 Creative, innovative and pro-active demeanour
	PE3.4 Professional use and management of information
	PE3.5 Orderly management of self, and professional conduct
	PE3.6 Effective team membership and team leadership