UNSW AUSTRALIA

Course Outline

Semester 1 2015

Never Stand Still | Faculty of Engineering | School of Mechanical and Manufacturing Engineering

MECH4305

Fundamental and Advanced Vibration Analysis

Contents

1. COURSE AT A GLANCE

Week	Topics	Assessments Due
1	Non-sinusoidal forcing of SDOF systems, convolution, Fourier transforms	
2	Euler-Bernoulli beams – free response and modes, forced vibrations, orthogonality of modes	
3	Hamilton's Principle and Lagrange's Equations for continuous systems	
4	Approximation and discretization methods – Rayleigh's Quotient, Rayleigh-Ritz Method, Assumed Modes	PS #1
5	Galerkin Methods, Timoshenko Beams	
6	Key aspects of vibration measurement – transducers, data acquisition, spectrum analysis and signal processing.	PS #2
7	Fundamental concepts in nonlinear vibrations - equilibria and stability	Quiz 1
8	Phase plane analysis	PS #3
9	Perturbation analysis of nonlinear systems	
10	Sub- and super-harmonic oscillators	PS #4
11	Time-dependent coefficients and Mathieu's Equation	
12	Limit cycles	PS #5
13	**No lecture**	Quiz 2 PS #6
EXAMS		Final Exam

* *N.B.* – schedule of topics is only notional and may be changed during the conduct of the course.

2. COURSE STAFF

Contact details and consultation times for course convener

Dr Nathan Kinkaid
Room 414, Electrical Engineering Building (G17)
Tel (02) 9385 4180
Email n.kinkaid@unsw.edu.au

Consultation about course matters will be available in person in Room 414 on Thursdays from 1300 – 1500. Other queries and questions can be directed by email or to a relevant Moodle forum.

Contact details and consultation times for additional lecturers

Dr Danielle Moreau
Room 464E, Electrical Engineering Building (G17)
Tel (02) 9385 428
Email d.moreau@unsw.edu.au

3. COURSE DETAILS

Units of credit

Units of credit: Six (6).
For MECH4305 (6UoC) this means roughly:

In class	3 hours per week
Self-study	7 hours per week
Total	10 hours per week

Weekly Schedule

Lecture:

Tuesday 0900-1100 **Room**: Colombo B

Problem Solving Classes:

Tuesday 1200-1300 **Room:** ElecEng225
Tuesday 1300-1400 **Room:** Old Main Building 114A
Tuesday 1600-1700 **Room**: Webster 256
Tuesday 1700-1800 **Room**: Webster 256

There is no parallel teaching in this course.

Aims of the course

The aim of this course can be stated simply: For everyone involved (staff, students, demonstrators) to progress further towards becoming really good 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.

Context

This course is a sequel to an introductory course in Vibrations (MMAN2300 or MMAN3300) 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 and designing oscillatory systems.

Expected student learning outcomes

Students who successfully complete this course will be able to:	**UNSW graduate attributes**[1]
1. Explain and describe principles and components of Vibration Analysis and their inter-relationships formally and informally, in writing and verbally, to technical experts, peers and lay people.	1.1, 1.3, 1.6
2. Model, approximate, analyse and simulate vibratory systems that include general forcing, general boundary conditions, and nonlinearities using appropriate computational tools as necessary.	1.2, 1.3, 1.4
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.	1.2, 1.3, 1.4
4. Demonstrate an ability to communicate clearly and precisely about technical matters related to Vibration Analysis.	1.6, 1.7, 1.8

UNSW's graduate attributes are shown at
https://my.unsw.edu.au/student/atoz/GraduateAttributes.html

UNSW graduates will be

1. Scholars who are:
   1.1. understanding of their discipline in its interdisciplinary context
   1.2. capable of independent and collaborative enquiry
   1.3. rigorous in their analysis, critique, and reflection
   1.4. able to apply their knowledge and skills to solving problems
   1.5. ethical practitioners

1.6. capable of effective communication
1.7. information literate
1.8. digitally literate

2. Leaders who are:
   2.1. enterprising, innovative and creative
   2.2. capable of initiating as well as embracing change
   2.3. collaborative team workers

3. Professionals who are:
   3.1. capable of independent, self-directed practice
   3.2. capable of lifelong learning
   3.3. capable of operating within an agreed Code of Practice

4. Global Citizens who are:
   4.1. capable of applying their discipline in local, national and international contexts
   4.2. culturally aware and capable of respecting diversity and acting in socially just/responsible ways
   4.3. capable of environmental responsibility

You are also encouraged to compare the learning outcomes with the Engineers Australia Stage 1 Competencies for Professional Engineers. Engineers Australia is the accrediting body for engineering education in Australia, and as such it is necessary that you are able to demonstrate these competencies by the time of your graduation in Engineering.

The Stage 1 Competencies can be found at:
http://www.engineersaustralia.org.au/sites/default/files/shado/Education/Program%20Accreditation/110318%20Stage%201%20Professional%20Engineer.pdf

4. 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. There will also be laboratory or practical exercises that you may have to complete during your self-study time.

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 above.

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 seeing the world, not as being filled with 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 of the course as possible 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.

5. ASSESSMENT

As much as is practicable, assessment in the course will be used to see if students have gained new ways of seeing, not to differentiate them from each other or to sort them. This is naturally limited by University rules concerning the grading of students and students desire to understand where they stand in relation to their peers. Further details of individual assessment tasks will be provided on Moodle, including submission procedures and the criteria by which grades will be assigned.

Late Submission Policy

Late submission of Problem Sets is **not** permitted in this course. Special consideration may be granted according to the policy listed in the section titled ‘Administrative Matters’ below.

Presentation Requirements

All assessed materials should be neat and clear, and demonstrate professionalism. Guidance can be found in the School’s publications Standard Specification for the

Presentation of Student Written Assignments and In a Nutshell, both of which are provided in The Guide (see School General Office if you do not have a copy). Individual Problem Sets must be submitted to your demonstrators on paper during your Problem Solving Class time of the week that they are due and include your name and student number. Alternate arrangements must be agreed to by the Course Convener prior to the due date.
Note: - alternate arrangements will be made for the submission of Problem Set #6.

Assessment Scheme

Marks	Assessment	Reason for assessment	Targeted student learning outcomes
50	6 x Problem Sets	To provide regular feedback to you on your basic progress in Learning Outcomes 1-4 periodically throughout the term, and to give you the opportunity to practice new techniques and skills with guidance from lecturers, demonstrators and your peers.	1, 2, 3, 4
20	2 x Quizzes	To provide you with feedback on your ability to solve problems related to current topics in the course independently and to familiarize you with the format and types of questions to be found on the Final Exam.	1, 2, 3
30	**Final exam**	To provide you a final chance to show your achievement of Learning Outcomes 1-3.	1, 2, 3
Total 100			

Assessment Schedule

Week	Assessments	Due Dates
4	Problem Set 1	Tuesday, 24/3
6	Problem Set 2	Tuesday, 14/4
7	Quiz 1	Tuesday, 21/4
8	Problem Set 3	Tuesday, 28/4
10	Problem Set 4	Tuesday, 12/5
12	Problem Set 5	Tuesday, 26/5
13	Quiz 2 Problem Set 6	Tuesday, 2/6 Friday, 5/6
Exams	Final Exam	TBA – Exam Period

Special Consideration and Supplementary Assessment

For details of applying for special consideration and conditions for the award of supplementary assessment, see *Administrative Matters for All Courses*, available from the School website.

6. ACADEMIC HONESTY AND PLAGIARISM

Plagiarism is using the words or ideas of others and presenting them 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 booklet which provides essential information for avoiding plagiarism: https://my.unsw.edu.au/student/academiclife/Plagiarism.pdf

There is a range of resources to support students to avoid 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. Information is available on the dedicated website Plagiarism and Academic Integrity website: http://www.lc.unsw.edu.au/plagiarism/index.html

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

Further information on School policy and procedures in the event of plagiarism is presented in a School handout, Administrative Matters for All Courses, available on the School website.

7. 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

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

School's website http://www.engineering.unsw.edu.au/mechanical-engineering/

Library http://info.library.unsw.edu.au/web/services/services.html

8. COURSE EVALUATION AND DEVELOPMENT

The UNSW CATEI process will be used to survey your responses to this course. In this way, we can identify the goods bits to keep for next time and the bits that need improving.

This is the first offering of this course in the last few years, so no examples of response to student feedback are available.

You are also encouraged to comment on all aspects of the course using the discussion forum within Moodle while the course is being conducted.

9. ADMINISTRATIVE MATTERS

You are expected to have read and be familiar with Administrative Matters, available on the School website. This document contains important information on student responsibilities and support, including special consideration, assessment, health and safety, and student equity and diversity.

Information on general Occupational Health and Safety policies and expectations is available here: www.ohs.unsw.edu.au

Enclosed footwear is a prerequisite for entering the school laboratories. Further information regarding the OHS requirements for laboratory work will be available on Moodle.

Examination procedures and advice concerning illness or misadventure are detailed in the Administrative Matters document, and in the event of any discrepancy between this course outline and that document precedence will be given to this course outline.

N Kinkaid February 2015