CVEN4308

Structural Dynamics

Term 3, 2022

Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Mehrisadat Makki Alamdari	m.makkialamdari@unsw.edu.au	Mon 10am-1pm	Room 714, Civil Engineering Building (H20)	9385 5018

School Contact 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)

Course Details

Units of Credit 6

Summary of the Course

Fundamentals of structural dynamic analysis for structures; free and forced vibration of single and multiple degrees of freedom systems; normal modal analysis; transient dynamic analysis by numerical integration; response spectrum; introduction to wind and earthquake loads; introduction to finite element analysis of structural dynamics.

Course Aims

The aim of this course is to introduce students to the concepts and techniques involved in structural dynamics and their practical applications in structural engineering. The course begins with an introduction of the dynamics of simple structures and then develops the fundamental knowledge of vibration analysis of multi-degree-of-freedom structures and continuous structures. Students will develop an understanding of the nature of dynamic loads produced by various sources including earthquakes and acquire the ability to assess the response of civil engineering structures to such loads. The material covered in this course is essential to the analysis and design of large-scale structures such as multi-story buildings, towers and long-span bridges that are susceptible to vibration. Specifically, this course aims:

- To build up your understanding of the fundamental concepts of structural dynamics.
- To understand the nature of dynamic loads.
- To be able to apply acquired theory to dynamic analysis of civil engineering structures.

Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. Understand and apply the fundamental concepts of system dynamics with specific focus and application to civil/structural engineering	PE1.1, PE1.2
2. Identify and specify various types of dynamic loading for structural analysis	PE1.3
3. Apply the laws of dynamics to establish simple and realistic mathematical models of engineering structures	PE1.2, PE2.1
4. Analyse the dynamic response to a dynamic load and other important parameters for structural design	PE2.1, PE2.3
5. Evaluate the dynamic susceptibility of structures and the limitations of modelling techniques	PE1.3, PE2.2, PE2.3, PE3.3
6. Apply dynamic analysis methods to practical problems in structural engineering and other disciplines	PE2.1, PE2.2, PE2.4

Learning Outcome	EA Stage 1 Competencies
7. Demonstrate collaborative skills by working with other students in teams	PE3.5, PE3.6

Teaching Strategies

This subject consists of a mixture of lectures and workshops.

Lectures will cover the theories of structural dynamics and its applications to structural engineering. Application of the theories to formulate guidelines in the analysis of practical engineering problems will be emphasized.

The workshops provide you with the opportunity to discuss the lecture material with your demonstrator and to solve the set workshop problems. In order to understand the subject matter well, it is essential to attend the workshop classes and solve the workshop problems by yourself.

For each hour of contact it is expected that a student will put in at least 1 hours of private study. You are recommended to review the lecture and workshop material weekly.

The teaching/learning activities are summarized in the following:

Lectures

- Cover fundamental principles and derivations underlying structural dynamics and material to be learned for assessment tasks
- Follow worked examples
- Hear announcements on course changes

Workshops

- Practice solving set problems
- Identify and resolve difficulties in theory and problem-solving
- Be guided by demonstrators
- Ask questions

Private Study

- Review lecture material and textbook
- List difficulties
- Preparation for the workshop and do set problems
- Reflect on class problems
- Study relevant references
- Download materials from Moodle
- Keep up with notices and find out marks via Moodle
- Join Moodle discussions of problems
- Work on assignment
- Prepare for quizzes

Assessments (assignments, examinations)

- Demonstrate your knowledge and skills
- Demonstrate higher understanding and problem solving

Additional Course Information

Suggested approaches to learning in this course include:

- Regular participation in lectures and workshops. Review lecture and workshop material. Follow worked examples. Reflect on class problems and quizzes.
- Weekly reading and recording of your learning.
- Appropriate preparation for workshop activities.
- Planning your time to achieve all assessment requirements (see assessment).
- Keep up with the notices via Moodle and UNSW email. It is your responsibility to check your UNSW email regularly. NOTE: Announcements made in emails are equally official as announcements made during lectures.
- We encourage you to work with your peers. A good way to learn the material is in small study groups. Such groups work best if members have attempted the problems individually before meeting as a group. A valued and honest collaboration occurs when, for example, you “get stuck” early on in attacking an exercise and go to your classmate with a relevant question. Your classmate then can learn from your question as well as help you.

Assessment

The assessment of this course will be based on two quizzes, one assignment and a final exam. The final grade will be based on the sum of the scores from each of the assessment tasks. The lecturer reserves the right to adjust the final scores by scaling.

Two in-class quizzes are scheduled for Weeks 3 and 9, respectively. They will be online and open book. The quizzes will be held under exam conditions. The purpose of the quizzes is to test your understanding of the fundamental concepts and your ability to apply learned strategies to relevant problems.

One assignment is to be submitted in Week 10. The purpose of the assignment is to expose you to a realistic structural dynamics problem, which requires you to apply what you have learned. Similar to engineering practice, this will require you to find additional information by asking, reading or discussing with your classmates, to critically evaluate your model and to formulate conclusions. Here, documentation is equally important as results. It is expected that you submit a report that is similar in scope, form, and style to what you would submit to a private or public client who has commissioned you with the dynamic analysis.

A mark of at least 40% in the final examination is required before the class work is included in the final mark.

Penalties

Late submissions of the assignment will be penalised ***at the rate of 5% of the maximum achievable mark per day*** *after the due time and date have expired.* ***Submissions that are more than 5 days late (unless special considerations have been granted) are not accepted and 0 marks are awarded.***

Late submissions of the quiz will be penalised by 25% of the maximum achievable mark per 10min and are not accepted after 30+ min past the due date and time.

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Quiz 1	5%	26/09/2022	1, 2, 3, 4
2. Quiz 2	15%	07/11/2022	1, 2, 3, 4
3. Assignment	20%	Week 10	1, 2, 3, 4, 5, 6
4. Final Exam	60%	Not Applicable	1, 2, 3, 4, 5, 6

Assessment 1: Quiz 1

Start date: 26/09/2022
Due date: 26/09/2022

Application of taught concepts on SDOF systems

Assessment 2: Quiz 2

Start date: 07/11/2022
Due date: 07/11/2022

Application of taught concepts on SDOF and MDOF systems

Additional details

•**Please note that both quizzes will be run during the lecture.**

•Both quizzes are open-book.

•Quizzes will be published online in Moodle and detailed solutions have to be uploaded to Moodle!

•Familiarise yourself with scanning apps or other approaches to generate pdfs that can be uploaded easily!

•Make sure you have access to your laptop as well as stable and fast internet connection!

•For the quiz, only one single pdf file must be uploaded via Moodle.

Assessment 3: Assignment

Due date: Week 10

Application of taught concepts on SDOF and MDOF systems, and earthquake response.

Additional details

•*Late submissions of the assignment will be penalised* ***at the rate of 5% of the maximum achievable mark per day*** *after the due time and date have expired.* ***Submissions that are more than 5 days late (unless special considerations have been granted) are not accepted and 0 marks are awarded.***

Assessment 4: Final Exam

Final exam

Hurdle requirement

Example: A mark of at least 40% in the final examination is required before the class work is included in the final mark.

Attendance Requirements

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

Course Schedule

Lecture

Monday 10am – 1pm (In person, K-H20-101)

Workshop

Tuesday, 4pm – 6pm (In person, K-H20-102)

Wednesday, 10am– 12pm (Online)

Public holiday: no lecture in week 4 (3rd of October Labour Day)

Flexibility week: no lecture/workshop in week 6

View class timetable

Timetable

Date	Type	Content
O-Week: 5 September - 9 September		
Week 1: 12 September - 16 September	Lecture	**Introduction** **Single-Degree-of-Freedom (SDOF) Systems** **Free Vibration of SDOF Systems**
Week 2: 19 September - 23 September	Lecture	**Harmonic Vibration of SDOF Systems**
Week 3: 26 September - 30 September	Assessment	**Quiz 1**
	Lecture	**Response to Periodic, Arbitrary, Step & Pulse Excitations of SDOF Systems** **Numerical Methods for Dynamic Response Evaluation**
Week 4: 3 October - 7 October		**Public Holiday Labour Day Monday 3 October**
Week 5: 10 October - 14 October	Lecture	**Multi-Degree-of-Freedom (MDOF) Systems**

		Free Vibration Analysis of MDOF Systems
Week 6: 17 October - 21 October		**Flexibility week for all courses (non-teaching)**
Week 7: 24 October - 28 October	Lecture	**Multi-Degree-of-Freedom (MDOF) Systems (continued)** **Harmonic Vibration of MDOF Systems** **Inverse Vector Iteration & Rayleigh's Method**
Week 8: 31 October - 4 November	Lecture	**Earthquake Response of Linear Systems (SDOF)** **Earthquake Response of Linear Systems (MDOF)**
Week 9: 7 November - 11 November	Assessment	**Quiz 2**
	Lecture	**Introduction to Wind Loading**
Week 10: 14 November - 18 November	Lecture	**Systems with Distributed Mass and Elasticity** **Structural Dynamics in the Finite Element Method**
	Assessment	Assignment

Resources

Prescribed Resources

Textbook (recommended):

Chopra, A. K. Dynamics of Structures, 4th ed.: Prentice-Hall 2015.

Available online from UNSW Library and in print at Main Library Level 7 (624.1762/92) and other locations.

Recommended Resources

1. Clough, R. W. and Penzien, J. Dynamics of Structures, 2nd ed.: McGraw-Hill 1993.

Available at Main Library Level 7 (P 624.171/112 A)

1. Bolton, A. *Structural Dynamics in Practice: a Guide for Professional Engineers*, McGraw-Hill 1994.

Available at Main Library Level 7 (P 624.171/212)

1. Rao, S. S. Mechanical Vibration, SI ed: Prentice-Hall 2011.

Available at Main Library Level 7 (620.3/143 AC)

1. Bachmann H., Amman W.J., *Vibrations in structures: induced by man and machines,* Zurich, Switzerland : IABSE-AIPC-IVBH, 1987

Available at Main Library Level 7 (P 624.176/55)

1. Humar, J. L. *Dynamics of Structures*, 3rd edition.: CRC Press/Balkema 2012

Available at Main Library Level 7 (624.171/194 A)

Submission of Assessment Tasks

Please refer to the Moodle page of the course for further guidance on assessment submission.

UNSW has a standard late submission penalty of:

- 5% per day, for all assessments where a penalty applies, capped at five days (120 hours), after which a student cannot submit an assessment, and no permitted variation.

Academic Honesty and Plagiarism

Beware! An assignment that includes plagiarised material will receive a 0% Fail, and students who plagiarise may fail the course. Students who plagiarise are also liable to disciplinary action, including exclusion from enrolment.

Plagiarism is the use of another person's work or ideas as if they were your own. When it is necessary or desirable to use other people's material you should adequately acknowledge whose words or ideas they are and where you found them (giving the complete reference details, including page number(s)). The Learning Centre provides further information on what constitutes Plagiarism at:

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

Academic Information

Final Examinations:

Final exams in T3 2022 will be held online between 25th November - 8th December 2022 inclusive, and supplementary exams between 9th - 13th January 2023 inclusive. You are required to be available on these dates. Please do not to make any personal or travel arrangements during this period.

ACADEMIC ADVICE

- Key Staff to Contact for Academic Advice (log in with your zID and password): https://intranet.civeng.unsw.edu.au/key-staff-to-contact-during-your-studies-at-unsw
- Key UNSW Dates - eg. Census Date, exam dates, last day to drop a course without academic/financial liability etc.
- CVEN Student Intranet (log in with your zID and password): https://intranet.civeng.unsw.edu.au/student-intranet
- Student Life at CVEN, including Student Societies: https://www.unsw.edu.au/engineering/civil-and-environmental-engineering/student-life
- Special Consideration: https://student.unsw.edu.au/special-consideration
- General and Program-Specific Questions: The Nucleus: Student Hub
- Book an Academic Advising session: https://app.acuityscheduling.com/schedule.php?owner=19024765

Disclaimer

This course outline sets out 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 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 (as updated in Moodle), the description in the Course Outline/Moodle applies.

Image Credit

Mike Gal.

CRICOS

CRICOS Provider Code: 00098G

Acknowledgement of Country

We acknowledge the Bedegal people who are the traditional custodians of the lands on which UNSW Kensington campus is located.

Appendix: Engineers Australia (EA) Professional Engineer Competency Standard

Program Intended Learning Outcomes	
Knowledge and skill base	
PE1.1 Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline	✓
PE1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline	✓
PE1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline	✓
PE1.4 Discernment of knowledge development and research directions within the engineering discipline	
PE1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline	
PE1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline	
Engineering application ability	
PE2.1 Application of established engineering methods to complex engineering 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	✓
Professional and personal attributes	
PE3.1 Ethical conduct and professional accountability	
PE3.2 Effective oral and written communication in 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	✓