Course Profile

SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING

THE UNIVERSITY OF NEW SOUTH WALES

CVEN 4308 Structural Dynamics – Session 2, 2013

COURSE DETAILS

Units of Credit	6	
Contact hours	4 hours per week	
Pre-requisites	CVEN3301, CVEN2702	
Lectures	Wednesday 09.00-11.00	CLB 3
Tutorials	Wednesday 11.00-13.00	CLB 3

Course Coordinator / Lecturer:

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INFORMATION ABOUT THE COURSE

Course Overview

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. This 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 wind, earthquake, waves and other sources 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. Much of the knowledge acquired in this subject is also applicable to dynamic problems in other areas such as geotechnical engineering, mechanical engineering and material science.

The flow chart in Figure 1 shows diagrammatically how this course relates to other courses in the Civil Engineering program.

This course will also provide you with opportunities to develop the following generic **graduate attributes**:

- the capacity for analytical and independent critical thinking;
- skills related to lifelong learning, such as self-reflection (ability to apply theory to practice in familiar and unfamiliar situations)

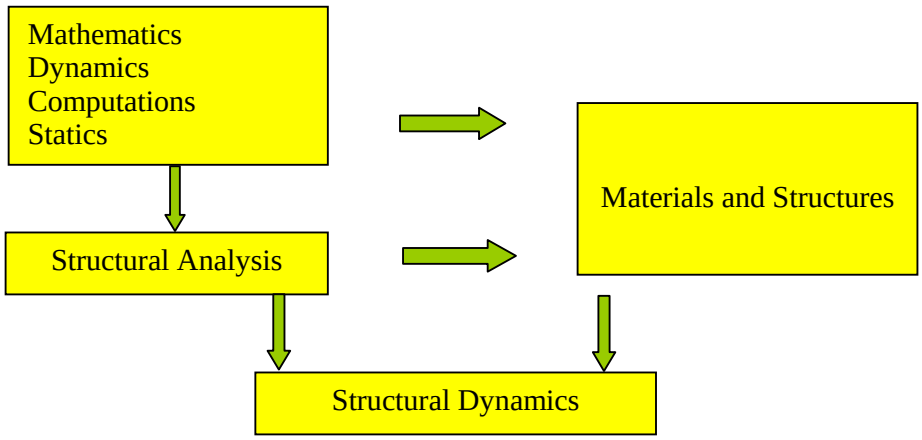

Figure 1. How this course relates to other courses in Civil Engineering.

Handbook description

Fundamentals of structural dynamic analysis for discrete and continuous 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 nonlinear dynamic analysis of structures; wind, earthquake, human-induced vibration and wave loads: definitions and effects on structures; design of structures to resist dynamic loads.

Objectives

The objectives of this course are:

- 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.
- To develop the ability of applying a commercial software package to structural dynamics.
- To understand the fundamental concepts of structural design against dynamic actions.

TEACHING STRATEGIES

This subject consists of a mixture of lectures, tutorials and hands-on computer sessions.

Lectures will cover the basic theories of structural dynamics and its applications to structural engineering. A commercial software package, which you will use to accomplish your assignment, will be introduced. Application of the theories to formulate guidelines in the analysis of practical engineering problems will be emphasized.

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

For each hour of contact it is expected that a student will put in at least 1.5 hours of private study. You are recommended to review the lecture and tutorial material weekly.

The teaching/learning activities are summarized in the following table:

Lectures	• Cover material to be learned for assessment tasks • Follow worked examples • Hear announcements on course changes
Tutorials	• Practice solving set problems • Be guided by tutors • Ask questions
Computer Sessions	• Hand on exercises using commercial software • Familiarise with pre- and post-processors • Reflect and discuss on practical issues in numerical simulation
Private Study	• Review lecture material and textbook • Prepare for the tutorial and do set problems • Reflect on class problems • Study relevant references
Assessments (hand-ins, assignment, quizzes, examination)	• Demonstrate your knowledge and skills • Demonstrate higher understanding and problem solving

Suggested approaches to learning in this course include:

- Regular participation in lectures and tutorials. *Review lecture and tutorial material. Follow worked examples. Reflect on class problems and quizzes.*
- Weekly reading and recording of your learning.
- Appropriate preparation for tutorial 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 has the opportunity to learn from your question as well as help you.
- Students who perform poorly in the quizzes are strongly encouraged to discuss their progress with the lecturer during the semester. Please do not suffer in silence – seek the help at an early stage! We would like you to make most of this learning process and receive a high grade in the course.

CONSULTATION

We would like for you to learn the material, gain the required skills and make a high grade in this course. Questions are welcome in class and during the consultation times. Ask your class mates, ask your tutor, ask me. Also, your comments/suggestions/criticisms, expressed either to your lecturers or tutor, are most welcome!

EXPECTED LEARNING OUTCOMES

At the conclusion of this course, students should be able to:

1. demonstrate an understanding of fundamental concepts of structural dynamics
2. gain the skills on applying the laws of dynamics to establish simple and realistic mathematical models of engineering structures
3. identify and specify various types of dynamic loads for structural analysis
4. determine the natural frequency, the dynamic response to a dynamic load and other important parameters for structural design
5. evaluate the dynamic susceptibility of structures
6. demonstrate the ability to apply the dynamic methods to solve practical problems in structural engineering and other disciplines
7. demonstrate collaborative skills by working with other students in TEAMS

ASSESSMENT

Assessment will be based on **ten homework hand-ins, two quizzes, one assignment** and **a final exam**.

- The purpose of **homework hand-ins** is to provide you with a clear study framework and to encourage a weekly revision of the material. It will also provide you with the opportunity to develop self-learning and problem solving skills. 10 homework hand-ins will be circulated by your tutor at the end of 10 selected classes. You need to submit the hand-in to the lecturer's assignment box marked "BIRK" on level 7 of the CE building by Tuesday, 6pm, of the following week. It will be returned to you a week after submission during the tutorial classes. A general marking of **Satisfactory = 1**, **Unsatisfactory = 0.5**, **Null = 0** will be given. A zero score will be given if you do not submit your homework in due date and time. The solutions of the homework problems will be uploaded a week after submission.

- **Two quizzes** are scheduled for Weeks **4** and **8** and will take place during the **last hour** of the 2-hour tutorial block. The duration of the quizzes is 50 minutes. The quizzes will be held under exam conditions.

- A mark of at least 40% in **the final examination** is required before the class work is included in the final mark. The formal exam scripts will not be returned.

The relative value of each of the assessable tasks is as follows:

Ten Homework Hand-ins:	**10%**
Quiz 1	**15%**
Quiz 2	**15%**
Assignment:	**15%**
Final Exam:	**45%**
	100%

There are no exemptions from any part of this assessment. **Note:** The course coordinator reserves the right to adjust the final scores by scaling if agreed to by the Head of School.

TEXTS AND RECOMMENDED READING

Textbook:

Chopra, A. K. *Dynamics of Structures*, 4th ed.: Prentice-Hall 2011.

Recommended Reading:

1. Clough, R. W. and Penzien, J. Dynamics of Structures, 2nd ed.: McGraw-Hill 1993.
2. Bolton, A. *Structural Dynamics in Practice: a Guide for Professional Engineers*, McGraw-Hill 1994.
3. Rao, S. S. Mechanical Vibration, SI ed: Prentice-Hall 2005.
4. Bachmann H., Amman W.J., *Vibration Problems in Structures: Practical Guidelines,* Birkhäuser, 1995
5. Humar, J. L. *Dynamics of Structures*, 3rd edition.: CRC Press/Balkema 2012

COURSE PROGRAM

W	Date	Lecture	Tutorial	Assessment
1	31/07	Introduction Types of dynamic loading Single-degree-of-freedom oscillator: equation of motion, free vibration analysis, natural frequency, undamped and damped systems, free vibration test	SDOF oscillator: free vibration	
2	07/08	Response to harmonic loading, frequency-response function, transmissibility, response to periodic loading	SDOF oscillator: particular and complete solution	Hand-in 1 Due
3	14/08	Response to periodic loading – continued; Response to arbitrary dynamic force: impulsive response, convolution (Duhamel) integral	Fourier series expansion / Duhamel integral	Hand-in 2 Due
4	21/08	Numerical integration: explicit and implicit methods, accuracy and stability	Numerical integration **QUIZ 1**	Hand-in 3 Due **QUIZ 1**
5	28/08	Multi-degree-of-freedom (MDOF) system: matrix equations of motion, generalized eigenvalue problem, inverse vector iteration	Equations of motion of 2-storey frame	Hand-in 4 Due
6	04/09	Modal analysis of MDOF system: mode shapes, modal superposition, free-vibration analysis, frequency- and time-domain analysis of forced vibration	Modal analysis	Hand-in 5 Due
7	11/09	Introduction to finite element analysis of structural dynamics by using commercial software: modelling issues, natural frequencies and mode shapes, response in frequency and time-domain	Computer session (1st group)	Hand-in 6 Due
8	18/09	Computer session (2nd group)	**QUIZ 2**	**QUIZ 2** Hand-in 7 Due
10	09/10	Continuous structures: partial differential equations of motion, Rayleigh's method	Rayleigh's quotient	Hand-in 8 Due
11	16/10	Guest lecture: Human-induced vibration	Analytical solutions for continuous systems	Hand-in 9 Due
12	23/10	Earthquake response, response spectrum concept	Earthquake response analysis (SDOF)	
13	30/10	Earthquake analysis of MDOF systems, Introduction to wind loading	Earthquake response analysis (MDOF)	Hand-in 10 Due **Assignment Due**

* The above timetable is indicative only and is subject to slight changes throughout the semester. Every effort will be made by the lecturers to inform students of variations to the above programme.

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 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:

http://www.lc.unsw.edu.au/onlib/plag.html

COMMON SCHOOL INFORMATION

PLEASE VISIT: http://www.civeng.unsw.edu.au/currentstudents/

COURSE EVALUATION AND DEVELOPMENT

The School of Civil and Environmental Engineering evaluates each course each time it is run through (i) the UNSW Course and Teaching Evaluation and Improvement (CATEI) process, and (ii) Focus Group Meetings.

As part of the CATEI process, your student assessments on various aspects of the course are graded; the Course Coordinator prepares a summary report for the Head of School. Any problem areas are identified for remedial action, and ideas for making improvements to the course are noted for action the next time that the course is run.

Focus Group Meetings are conducted by the four Year Managers (academic staff) for any students who wish to attend, in each year of the civil and/or environmental engineering programs. Student comments on each course are collected and disseminated to the Lecturers concerned, noting any points which can help improve the course.