The University of Western Ontario
Faculty of Engineering
Department of Civil and Environmental Engineering

CEE 9610 – Advanced Structural Dynamics
Fall 2018

The objectives of the course are for the student to become able to:

- Understand and derive the governing equations of motion of a single and multi-degree of freedom system.
- Perform free and forced vibration response of a dynamical system under a general loading.
- Develop the ability to characterize random variables and stationary stochastic processes.
- Develop the ability to interpret and analyze random vibration data with the aid of auto-correlation function and power-spectral density functions.
- Perform different system identification methods and analyze time-invariant linear dynamical systems.
- Develop the ability to perform vibration testing including free vibration, forced vibration and ambient vibration testing to extract relevant system information of structures.

Prerequisites
None.

Corequisites
None.

Antirequisites
None.

Contact Hours
3 lecture hours per week (Thursday: 10:30 am – 1:30 pm, Room: 3C+ 1415)

Instructor
Dr. Ayan Sadhu, P. Eng.
E-mail: asadhu@uwo.ca
Office: SEB 3020B; Extension: 81431
Administrative support: Ms. S. Laurence, SEB 3005

Textbook
None.

References

1. Rao, S (2017). Mechanical Vibration, 6th Edition, Pearson.
2. Chopra, A.K. (2006). Dynamics of Structures: Theory and Applications to Earthquake Engineering, 3rd Edition. Prentice Hall.
3. Humar, J.L. (2002). Dynamics of Structures, 2nd Edition. A. A. Bulkema Publishers.

4. Meirovitch, L. (2001). Fundamentals of Vibrations, International Edition. McGraw-Hill.
5. Clough, R.W. and Pensien, J. (1993). Dynamics of Structures, 2nd International Edition. McGraw-Hill.
6. Juang, J-N. (1994). Applied System Identification, Prentice Hall, New Jersey.
7. Newland, D. E. (1984). An Introduction to Random Vibrations, Spectral and Wavelet Analysis, Prentice Hall, Third Edition.
8. Farrar, C.R. and Worden, K. (2013). Structural Health Monitoring: A Machine Learning Perspective, First Edition, Wiley.

Lecture Notes
Lecture notes prepared by Dr. Sadhu will be disseminated during the lectures.

Laboratory
N/A

Units
SI units will be used in lectures, assignments and examinations

Specific Learning Objectives:

1. **Background of Dynamics**
    a. Second-order differential equations and basics of matrix operations
    b. Free-body diagram and degree-of-freedom (DOF)
    c. Free and forced vibration of a single DOF (SDOF) system
    d. Damped vibration and logarithmic decrement
    e. Response of a SDOF system under general loading

2. **Multi-DOF (MDOF) System**
    a. Modal superposition
    b. Free and forced vibration
    c. Rayleigh damping
    d. Concepts of design spectra, modal combinations and earthquake engineering

3. **Random Vibration**
    a. Introduction to probability and basic statistics
    b. Random process, stationary process
    c. Auto-correlation functions and power spectral density functions
    d. Response of a linear system subjected to stationary input

4. System Identification

i. State-space representation

ii. Parametric and non-parametric methods

iii. Time and frequency domain methods

iv. Experimental modal analysis

5. Vibration Sensing and Monitoring

a. Sensors and data acquisition systems, sampling and zero-order hold

b. Free, forced and ambient vibration testing

Assignments

A total of 6/7 assignments will be posted which will be due on a specific date during the class hours. The penalty for late submission is 10% per day late.

Examinations

A final examination will be held on December 10th covering entire course material. It will be a three-hour open book examination.

Methods of Evaluation

The final grade is computed as follows:

Assignments	30%
Project	20%
Final Exam	50%
TOTAL	**100%**

Students must pass the final examination to pass this course. Students who fail the final examination will be assigned the aggregated mark as determined above, or 48%, whichever is less.

Project details: Individual projects are assigned to each graduate students which will be submitted in terms of a project report. It will be based on the topics discussed in the lectures and should involve programming using MatLab/Fortran. The project details and topics will be posted in the first week of October. The report will be due in the last class.

English

In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests and examinations for the improper use of English. Additionally, poorly written work with the exception of final examinations may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

Scholastic Offence
Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following website: http://www.uwo.ca/univsec/handbook/appeals/scholastic_discipline_grad.pdf

Consultation
Students are encouraged to discuss problems with their teaching assistant and/or instructor in tutorial sessions. Other individual consultation can be arranged by appointment with the instructor.

Cheating
University policy states that cheating is a scholastic offence. The commission of a scholastic offence is attended by academic penalties that might include expulsion from the program. If you are caught cheating, there will be no second warning.

Conduct
Students are expected to arrive at lecture on time, and to conduct themselves during class in a professional and respectful manner that is not disruptive to others.

Sickness and Other Problems
Students should immediately consult with the instructor regarding any problem that could affect their performance in the course. The student should seek advice from the Instructor or Department Chair regarding how best to deal with the problem. Failure to notify the Instructor or Department Chair immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

Notice
Students are responsible for regularly checking their e-mail, the course owl site.