CE 563 - Introduction to Structural Dynamics

Class hours: 2:00PM - 3:15PM T TH, Spring 2018. Room 401 ESB. **CRN:** 17578

· **Instructor: Dr. Hung-Liang (Roger) Chen, Professor**
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Course Description:

General theory for dynamic response of systems having one or several degrees of freedom. Emphasis on the application of dynamic response theory to structural design.

TOPICS

1. Introduction

2. Undamped Single Degree-of-Freedom Systems (SDOF) **:** 1. Degrees of freedom; 2. Undamped System; 3. Springs in parallel or in series; 4. Newton's law of motions; 5. Free body diagram; 6. D'Alembert's principles; 7. Solution of the differential equation of motion; 8. Frequency and period; 9. Amplitude of motion.

3. Damped SDOF: 1. viscous damping; 2. Equation of motion; 3. Critically damped system; 4. Overdamped system; 5. Underdamped system; 6. Logarithmic decrement.

4. Response of SDOF to Harmonic Loading: 1. Undamped system; harmonic excitation; 2. Damped system; harmonic excitation; 3. Evaluation of damping at resonance; 4. Response to support motion; 5. Force transmitted to foundation.

5. Response to General Dynamic Loading: 1. Impulsive loading and Duhame's integral; 2. Response spectra of commonly used dynamic forces.

6. Response spectra: 1. Construction of response spectrum; 2. Response spectrum for support excitation; 3. Seismic response spectra for elastic design.

7. Random Vibration; 1. Introduction to Fourier series and Fourier transform; 2. Statistical description of random functions; 3. Normal distribution and Correlation; 4. Spectral Analysis; 5. spectral density function; 6. Response to Random excitation.

8. Damping in Structural System; 1. Classification and types of damping;
   2. Equivalent viscous damping.

9. Basics of finite Element analysis: 1. Introductory example on static analysis;
   2. Example on dynamic analysis.

10. Dynamic Analysis of Multi-degree-of-freedom systems: 1. Equations of motion;
    2. Modal analysis; 3. How to incorporate damping; 4. Model superposition;
    5. Direct integration; 6. Frequency response; 7. Response spectrum.

11. Analysis of Systems with Distributed Properties; 1. Flexural vibration of uniform beams; 2. Solution of Equations of Motion; 3. Modal Analysis; 4. Forced vibration of beams; 5. Stresses in beams.

12. Analysis of Nonlinear Structural Response; Analysis of Nonlinear Structural Systems; Step by step time integration methods.

13. Special Topics: 1. Design of Structures to blast Loads: 2. Use of general purpose FEM program to perform modal analysis; 3. Experimental modal testing.

GRADING WILL BE BASED UPON:

a. Homework 60 pts.
b. Exams (2) 140 pts: Midterm 60 pts. and Final 80 pts.

Grade A = 170 to 200; Grade B = 169 to 145;
Grade C = 144 to 120; Grade D = 119 to 90; Grade F < 90.

RECOMMENDED TEXT:

1. Dynamics of Structures, by Clough and Penzien, 2nd edition, CSI, 2004 revision. http://www.csiamerica.com/

RECOMMENDED REFERENCES:

1. Structural Dynamics, Theory and Application, by J. W. Tedesco, Addison Wesley, 1999.
2. Dynamics of Structures, Theory and Application to Earthquake Engineering, by A. K. Chopra, 5th ed., Prentice Hall, 2016.
3. Humar. J. L., Dynamics of Structures, 3rd ed., CRC Press, 2012.
4. Notes and reference listing in class.