

## CEE 696 – Earthquake Engineering

### Instructor

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### Course Description

This course is designed to introduce students to the fundamental concepts in earthquake engineering. The findings from some of recent research studies will be introduced, and students will also gain experience in using the state-of-the-art tools that are commonly utilized by the earthquake engineering community.

### Textbook

- *Fundamentals of Earthquake Engineering: From Source to Fragility*, 2nd Edition, Amr Elnashai and Luigi Di Sarno, ISBN-13: 978-1118678923

### Reference Textbook

- *Fundamentals of Structural Dynamics*, 2nd Edition, Roy R. Craig, Andrew J. Kurdila, ISBN: 978-0471430445
- *Dynamics of Structures: Theory and Applications to Earthquake Engineering*, 5th Edition, Anil K. Chopra, ISBN-13: 978-0134555126
- *Geotechnical Earthquake Engineering*, 1st Edition, Steven L. Kramer, ISBN-13: 978-0133749434
- *Fundamental Concepts of Earthquake Engineering*, 1st Edition, Roberto Villaverde, ISBN-13: 978-1420064957
- *Structural Analysis*, 10th Edition, Russell C. Hibbeler, ISBN-13: 978-1292247137
- *Concepts and Applications of Finite Element Analysis*, 4th Edition, Robert D. Cook, David S. Malkus, Michael E. Plesha and Robert J. Witt, ISBN-13: 978-0471356059

### Attendance

University policy on class attendance must be followed. Regular attendance at class is expected. Unavoidable absences should be explained to the instructor.

### Pop-up Quizzes

There will be several unannounced, 5-minute quizzes. Worst one quiz will be dropped.

## Homework Assignments and Projects

- Homework assignments will be given periodically based on the materials covered. Homework must be neat and well-presented; sloppy homework will be returned as unsatisfactory. Late homework will receive a reduced grade. Also, the instructor will not accept any late homework after 5 days of the originally scheduled date.
- Project #1: An in-depth investigation of a major earthquake  
The students will work individually or in small groups (depending on the size of the class) to prepare a report. The reports should cover all aspects of the earthquake including tectonic setting and seismic history, seismology and strong motion, structural damage, geotechnical effects, and social and economic impacts. The reports should be in the format of a journal paper with a maximum length of 10 pages. Each student (or group) will prepare a short presentation and present his/her work to class.
- Project #2: Assessment of a multi-story building subjected to earthquake forces  
The students will start from the excitation source, and they will be responsible for performing all the intermediate steps to obtain the response of the structure. Finally, the performance of the structure will be quantitatively assessed. The students will submit the results in a technical report format. Computer lab sessions will be held as needed to help students use the required computer programs. Details regarding Project 2 will be provided later.
- Students are encouraged to work together, exchange ideas and information regarding homework assignments and projects; however, each student is responsible for making a separate submission of his/her own (unless it is a group assignment/project).

## Computer Program

Some homework assignments and the second project require the use of ZEUS NL, fiber-based finite element analysis software (available from <http://code.google.com/p/zeus-nl/>) and SAP2000, general purpose structural analysis software. Students are also encouraged to use other computer programs such as MATLAB and MS Excel.

## Grading

The course grades will be determined based on the following approximate grade basis.

Quizzes	5%
Homework	20%
Two Projects	25%
Midterm Exam	20%
<u>Final Exam</u>	<u>30%</u>
Total	100%

A midterm exam is scheduled during the normal class hours. The final exam is TBA.

## List of Topics

### *Earthquake Characteristics*

- Causes of Earthquakes
  - Plate tectonics theory

- Faulting
- Seismic waves
- Measuring Earthquakes
  - Intensity
  - Magnitude
  - Intensity-magnitude relationships
- Source-to-Site Effects
  - Directional Effects
  - Site Effects
  - Dispersion and Incoherence
- Effects of Earthquakes
  - Damage to buildings and lifelines
  - Effects on the ground
  - Human and financial losses

### ***Response of Structures***

- Conceptual Framework of Seismic Design
- Structural Response Characteristics
  - Stiffness
  - Strength
  - Ductility
  - Overstrength
  - Damping

### ***Earthquake Input Motion***

- Earthquake Occurrence and Return Period
- Attenuation Relationships
- Earthquake Spectra
- Earthquake Records
- Duration and Number of Cycles of Earthquakes Ground Motions
- Use of Earthquake Databases
- Software for Deriving Spectra and Generation of Ground Motion Records

### ***Response Evaluation***

- Ground Motion and Load Modeling
- Seismic Load Combinations
- Structural Modeling
- Methods of Analysis
- Performance Levels and Objectives
- Output for Assessment