Fall 2010

Introduction to Earthquake Engineering
CEES 5020.900
MW: 6:00 - 7:15 pm
CEC Room 119

Instructor: Dr. Kianoosh Hatami
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Description:

The purpose of this course is to provide higher level undergraduate and graduate students an understanding of the effects of earthquakes on civil engineering structures and analytical tools for their seismic analysis. The course begins with introducing some seismological background including sources and characteristics of earthquakes and related terminology, followed by a review of structural dynamics and discussions on characteristics of strong ground motion, and seismic hazard analysis.

The course continues with introducing available methods for seismic analysis of structures including pseudo-static (equivalent static force) and pseudo-dynamic (i.e. response spectra and modal analysis) approaches. Topics such as numerical methods of dynamic analysis, inelastic response of structures, earthquake response of special structures (e.g. bridges, dams and retaining walls), seismic hazard mitigation techniques and damage evaluation will be discussed through participation of students on an interactive, term-paper basis.
Course outline (Subject to revision):

1. **Seismological Background** (Ch. 1 & 2)*
   a. Seismicity and seismic sources
      i. Plate tectonics
      ii. Faults
      iii. Elastic rebound theory
      iv. Causes and characteristics of earthquakes
      v. Other sources of seismic activity
   b. Seismic waves
   c. Size of earthquakes
   d. Location of earthquakes
   e. Significant historical earthquakes

* Kramer (1996) – see last page.

2. **Earthquake response analysis of elastic structures** (App. B)
   a. Review of structural dynamics
      i. Single degree of freedom systems (SDOF)
         1. Free-vibration response
         2. Response of SDOF systems to periodic loading, Fourier Series Analysis
         3. Response to impulse loading
         4. Response to general dynamic loading, Duhamel Integral
      ii. Multi-degree of freedom systems (MDOF) - symmetric structures
         1. Modal analysis: natural frequencies and mode shapes
         2. Normal coordinates and mode superposition procedure
         3. Rayleigh’s method for estimation of natural frequency
         4. Time-domain vs. frequency domain analysis

Midterm I

3. **Strong Ground Motion** (Ch. 3)
   b. Strong ground motion characteristics
      i. Definitions of ground motion parameters
      ii. Estimation of ground motion parameters
      iii. Spatial variation of ground motions and site effects
   c. Strong-motion measurement
      i. Seismographs
      ii. Accelerometers
iii. Strong-motion data acquisition, instrument arrays, processing and records
d. Seismic maps and seismic zones

4. Earthquake response analysis of elastic structures (Ch. 8)

b. Response spectrum approach
   i. Spectral displacement, pseudo-velocity and pseudo-acceleration responses of the ground motion
   ii. Fourier spectrum vs. response spectrum
   iii. Construction of combined (Tripartite) response spectrum
   iv. Calculation of peak structural response
   v. Characteristics of response spectrum
   vi. Elastic design response spectra
   vii. Selection of design earthquakes
       1. Site-specific ground motion histories
       2. Selection and modification of recorded histories
       3. Generation of synthetic histories

c. Review of IBC 2000 seismic design provisions

Midterm II

5. Seismic Hazard Analysis - Time permitting (Ch. 4)
   a. Deterministic seismic hazard analysis (DSHA)
   b. Probabilistic seismic hazard analysis (PSHA)

6. Basic Ground Response Analysis – Time permitting (Ch. 7)
   a. 1D ground response analysis
   b. Amplification and attenuation of local ground motion
   c. Material damping vs. radiation damping

7. Special topics (student presentations)
   a. Numerical approaches to seismic analysis of structures
   b. Earthquake response analysis of inelastic structures
   c. Review of seismic building codes
   d. Damage evaluation in structures
   e. Retrofitting techniques
   f. Methods of response reduction in structures
   g. Seismic response of special structures (e.g. Bridges, retaining structures, dams, water tanks, lifelines)
   h. Soil dynamics
   i. Emergency management
   j. Other
Primary References:


5. Related websites

Test Policy:

There will be two mid-term tests and a term paper/presentation, which will be due at the end of the semester.

Assignments 15%
Midterm tests 25 % each
Final term paper and presentation 35 %

Reasonable Accommodation Policy:
"Any student in this course who has a disability that may prevent her or him from fully demonstrating his or her abilities should contact the instructor personally as soon as possible so as to discuss accommodations necessary to ensure full participation and facilitate your educational opportunities."