CEE 675 – STRUCTURAL DYNAMICS I

Instructor

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Course Description

This course covers the basics of the theory of structural dynamics. Topics covered include: response of single and multi degree-of-freedom systems due to dynamic forces; direct integration of equations of motion; response spectrum analysis. The course objectives are: to understand principles of structural dynamics; to apply the principles to solve problems; to interpret results; and to use MATLAB software to solve problems.

Textbook

Roy R. **Craig**, Andrew J. **Kurdila**, "***Fundamentals of Structural Dynamics***", 2nd Edition, ISBN: 978-0471430445

Reference Textbook

Anil K. **Chopra**, "***Dynamics of Structures: Theory and Applications to Earthquake Engineering***", 5th Edition, ISBN: 978-0134555126

Required Program

The software program **MATLAB** will be required to do some of the homework assignments. An academic version of MATLAB is available at https://www.hawaii.edu/sitelic/matlab/ for free.

Grading

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

Homework	30%
Midterm	30%
Final	40%
Total	100%

Homework assignments will be given periodically (weekly) 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.
One midterm exam is scheduled during the normal class period. The final exam is TBA.

List of Topics

Part I: Single-Degree-of-Freedom Systems

- Mathematical Models of SDOF Systems

  - Newton's laws
  - Principle of virtual displacements
  - Assumed-mode method
- Free Vibration of SDOF Systems
  - Undamped free vibration
  - Viscous-damped free vibration
  - Columb-damped free vibration
  - Experimental determination of natural frequency and damping
- Response of SDOF Systems to Harmonic Excitation
  - Undamped system response
  - Viscous-damped free vibration
  - Complex frequency response
  - State space representation of the equations of motion
  - Vibration isolation
- Response of SDOF Systems to Nonperiodic Excitation
  - Response of viscous-damped SDOF system to step input
  - Response of viscous-damped SDOF system to pulse and ramp loadings
  - Impulse response function
  - Response of viscous-damped SDOF system to general input: convolution integral
  - Response Spectra
  - Laplace transform and system transfer function
- Response of SDOF Systems: Frequency-domain Analysis
  - Response to periodic excitations – real Fourier series
  - Response to periodic excitations – complex Fourier series
  - Response to nonperiodic excitations – Fourier integral
  - Relationship between the frequency response and impulse response functions
- Numerical Evaluation of the Dynamic Response of SDOF Systems
  - Integration of second-order ordinary differential equations
  - Integration of first-order ordinary differential equations

Part II: Multi-Degree-of-Freedom Systems

- Mathematical Models of MDOF Systems
  - Application of Newton's laws
  - Lagrange's equations
  - Assumed-mode method
- Vibration Properties of MDOF Systems
  - Natural frequencies and mode shapes
  - Uncoupled damping in MDOF systems
  - Structures with arbitrary viscous damping – complex modes shapes
- Dynamic Response of MDOF Systems: Mode-superposition Method
  - Mode-superposition method: time domain
  - Mode-superposition method: frequency domain
- Earthquake Response Spectra