

CE529 Soil Dynamics

Fall 2026-2027

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Course hours: Monday, 09:45-12:30 pm

Objectives: To introduce students to the fundamental of soil dynamics and its applications to modern geotechnical and earthquake engineering where dynamics loading and response analysis are critical design aspects.

Course outline:

1. Introduction: Sources of dynamic loads and applications in geotechnical, structural, foundation, and earthquake engineering; characteristics of different soil dynamic problems.
 2. Single degree of freedom systems: free and forced vibration; energy balance; Duhamel integral; numerical integration; spectrum techniques, transfer functions
 3. Dynamic soil properties: basic characteristics; measurement by resonant column, geophysical, simple shear, triaxial tests, empirical relationships; nonlinear strain dependence of soil modulus and damping
 4. Multi-degree of freedom systems: natural frequencies and mode shapes; principal coordinates and modal analysis; forced vibrations; participation factors; damped vibrations; application response spectrum techniques; transfer functions for MDOF systems
 5. Introduction to earthquake engineering
 6. Liquefaction: physical phenomena and concepts, methods of analysis, and evaluation procedures
- If time permits:**
7. Continuum systems: 1-D models in dynamic and wave propagation analyses; wave propagation in 2D and 3D; wave equations, wave types; reflection and refraction, mode conversions
 8. Foundation dynamics: design criteria, vibration of foundations; dynamic soil-structure interaction; methods of analysis by mechanical analogs and frequency-dependent impedance functions, impedance modification factors

Prerequisite: Basic courses in soil mechanics and analytical dynamics, or consent of instructor.

Attendance is mandatory.

Grading: (I) Homework: 30 %; (II) Term Project: 30 %; (III) Final Exam: 40 %

References:

Soil Dynamics & Structural Dynamics:

Richart, Hall, and Woods, Vibrations of soils and Foundations

Das, Principles of Soil Dynamics

Kramer, Geotechnical Earthquake Engineering, Prentice Hall

Meirovitch, Elements of Vibration Analysis

Clough and Penzien, Dynamics of Structures

Wave Propagations:

Achenbach, Wave Propagation in Elastic Solids

Wolf, J., Dynamic Soil-Structure Interaction

Graff, Wave Motion in Elastic Solids

Ewing, Jardetsky, and Press. Elastic Waves in Layered Media

Class-handouts:

Journal papers, conference proceedings, notes