CIV E 661: Dynamics of Structures

Winter 2026 (January 5 – April 10)

Department of Civil and Environmental Engineering

University of Alberta

Instructor:	Dr. Nima Shirzad-Ghaleroudkhani
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Lecture Time and Location:	Mon Wed 15:30 – 16:50, NRE 2-080
Office Hours:	Fri 15:00 – 16:30, DICE 7-321

Course Description

This course offers a comprehensive introduction to structural dynamics, covering diverse topics crucial for understanding structural behavior. Students will explore free vibration analysis in both single and multiple degree of freedom systems. The course delves into responses to various excitations including harmonic, periodic, arbitrary, step, and pulse, emphasizing numerical methods for analysis. Additionally, it focuses on earthquake response, introducing the response spectrum concept and analysis techniques. Modal analysis will be covered alongside the utilization of analysis and computing software specific to structural dynamics. Throughout the course, students will learn solution techniques and gain proficiency in evaluating and presenting engineering problems within the realm of structural dynamics.

Grading Policy

Assignments ……..…. 20%

Midterm Exam (TBD) ……..……. 30%

Final Exam (based on the university's calendar) …...……...…. 40%

Project (TBD) ….……..……. 10%

Recommended Textbook

- "Dynamics of Structures: Theory and Applications to Earthquake Engineering" by Anil K. Chopra, Pearson Prentice Hall, 6th Edition, 2022.

Pre-requisites

- General knowledge of structural analysis, matrix algebra, differential equations, or consent of the instructor. Basic computer programming and structural modeling/analysis using commercial software are also needed for assignments and for the projects.

Course Delivery

- **Lectures:** These will take place twice a week, delivered in person by the instructor. To reinforce learning, some online quizzes will be conducted during lectures. These quizzes will contribute to bonus grading, with further details to be announced later.
- **Office hours:** The instructor will hold in-person office hours once a week. Scheduling for online meetings with the instructor is available upon request.
- **Assignment submission:** All assignments must be submitted electronically through eClass as per the due date and time.
- **Exams:** Both the mid-term and final exams will be conducted in person.
- **Final project:** Evaluation for the final project will solely rely on written reports; no presentations are required.

Course Policy

Materials and Lectures:

- Course materials are accessible on the course webpage (i.e., eClass). Handouts will generally not be distributed in class.
- Lectures will be presented using various formats (e.g., whiteboard and slides). Some slides intentionally contain limited details, with additional information provided during class sessions. Annotated notes will be accessible on eClass; however, the availability of whiteboard notes is not guaranteed. Students are responsible for taking notes from the whiteboard.

Assignments and Exams:

- Assignments and project must be submitted by the specified due date and time. **Late submissions will not be accepted**. To accommodate unforeseen circumstances, the weight of one out of seven assignments with the lowest score will be excluded.
- Assignment solutions will be made available after the collection of all assignments.
- Clearly written assignment reports are expected, adhering to specific guidelines:
  - Name
  - Course number
  - Assignment set number
  - Problem number
  - Results highlighted with appropriate units
  - Page number/total pages
  - Acknowledgment of collaborators or a declaration of independent completion
- Assignments must be neatly and clearly presented for grading, as the TA reserves the right not to grade poorly presented work.
- Assignment grading is based on steps and understanding, not solely on final answers.
- Self-written computer programs and structural analysis software solutions should include comprehensive documentation and processed data, not just output files.
- No make-up exams are permitted. In case of extreme circumstances leading to absence from the midterm exam, students must inform the instructor via email before the exam time to potentially shift the weight to the final exam.

Class Policy:

- Regular attendance at lectures is highly encouraged but will not be formally recorded. Discussion and collaboration among students are welcomed; however, each student must submit their own version of the assignments and project, citing any collaboration.

Academic Honesty:

- Students are expected to uphold academic integrity in all aspects of the course. Students are accountable for every assignment, report, or exam they submit. Lack of awareness of the academic honesty policy is not an acceptable explanation for any violations. Details of the Code of Student behavior policy can be found online.

Tentative Course Outline

Week 1:

- Introduction
  - Dynamic problems, dynamic loading, and dynamic analysis
  - Definitions of degree of freedom, SDOF, and MDOF systems
- Single-Degree-of-Freedom (SDOF) Systems
  - Force-displacement relation
  - Damping force
  - Equation of motion

Week 2:

- SDOF Systems – Free Vibration
  - Undamped free vibration
  - Viscously damped free vibration

Week 3:

- SDOF Systems – Forced Vibration
  - Response to harmonic and periodic excitations
  - Harmonic vibration of undamped systems
  - Harmonic vibration with viscous damping

Week 4:

- Applications of Viscously Damped Systems
- Response to Periodic Excitation

Week 5:

- Response to Arbitrary Excitations
- Response to Step Force
- Response to Pulse excitations

Week 6:

- Numerical Evaluation of Dynamic Responses
  - Central difference method
  - Newmark's method

Week 7:

- Earthquake Response of Linear Systems

    - Response spectrum
    - Design spectrum
- Earthquake Response of Inelastic Systems
    - Introduction to concepts
    - Reduction factor and ductility factor

Week 8:

- Multi-Degree-of-Freedom (MDOF) Systems
    - Equation of motion
    - Shear buildings
- MDOF Systems – Free Vibration
    - Natural frequencies and modes

Week 9:

- MDOF Systems – Free Vibration
    - Free vibration response of systems without damping
    - Free vibration response of systems with damping

Week 10:

- MDOF Systems – Forced Vibration
- Dynamic Analysis of Linear Systems
    - Modal analysis
    - Modal response contributions

Week 11:

- Earthquake Analysis of Linear Systems
    - Response history analysis
    - Response spectrum analysis

Week 12:

- Solving examples and practice exam