Analysis of Framed Structures

[Time] Tues. and Thurs. 11:00 AM – 12:15 PM
[Location] ECCR 105

[Instructor] Professor Abbie Liel
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[Office Hours] Mon./Wed. 2–3:30 PM. For other times, please make an appointment.

[Graders] Lan Nguyen and Chris Segura
[Office Hours] Mon. 10-12. Location TBA.
[Other] All course documents will be available on CULearn. Check your email for updates on course schedule and assignments.

Course Description and Objectives

By the completion of this course you should be able to:

(1) Describe and explain underlying assumptions in structural analyses and idealize (model) structures for the purpose of analysis.
(2) Conduct linear analysis of frame and truss structures (by hand and using the Matlab software package) in order to obtain structural deflections, reactions and internal forces.
(3) Compute and describe the effects of material or geometric nonlinear behavior on structural analysis results for simple frame and truss structures.
(4) Critically evaluate structural response output from commercially available structural analysis software packages.

Prerequisites

Structural Analysis (CVEN 3525 or equivalent)
Mechanics of Materials I (CVEN 3161 or equivalent)

You also need a basic understanding of matrix mathematics (multiplying matrices, inverting matrices, solving systems of equations). If you are uncomfortable with these topics, it is important that you review them early in the semester.

Course Requirements and Assessment

The lectures, homework assignments, programming project and exams will explore the important aspects of analysis of structures by hand and using computers. In-class time will be spent in lectures, problem solving and discussion. Attendance is critical for developing understanding and skills needed for homework assignments and exams.

Your grade in this course will be weighted as shown for a total of 100%:

- Weekly homework assignments [25%]
- Exams – Midterms [15% each] and Final [25%] (See note about final exam below.)
- Matlab programming project [20%] (Note: Students enrolled in CVEN 5525 will be expected to meet additional requirements in the programming assignment).

The grading scale is not curved and will be taken as follows -- A: 90 to 100%, B: 80 to 89.9%, C: 70 to 79.9%, D: 60 to 69.9%, F: 59.9% and below.

Exams

The first midterm exam is scheduled to be held in class on **Tuesday September 28**. The second midterm exam is scheduled to be held in class on **Thursday November 18**. The final exam is scheduled for **Monday December 13** from 4:30 to 7:00 PM. Keep these times free – alternate exam times will be available only under special circumstances. All exams will have a conceptual (closed book) section and a computational (open book, open notes) section. If your score on the final exam is better than both of the midterms, that grade can be used to replace the lower midterm score.

Homework Assignments

You have the choice of submitting your assignment individually or in groups of 2. No late homeworks will be accepted. Homework assignments will be graded both for numerical answers and conceptual understanding – so don't worry too much if you made a calculation error but your thought processes are correct!

Matlab Programming Project

There will be a Matlab programming assignment, which we will begin in late September. I will offer a Matlab tutorial session late September in the Bechtel lab for those who want a refresher on getting started in Matlab.

Textbook

McGuire, Gallagher, Ziemian, Matrix Structural Analysis, 2nd Edition, John Wiley & Sons, Inc., 2000. *Recommended*, especially if you're planning on continuing in structural engineering. Available at the bookstore. There is also a copy on reserve in the library.

Course Schedule

1. Introduction to Matrix Structural Analysis
   - Structural Idealization and Assumptions
   - Goal of Structural Analysis

2. Stiffness Method for Trusses (Axial Deformations)
   - Introduction to Coordinate Systems
   - Element Stiffness Coefficients
   - Element Stiffness Matrices

3. Structural Analysis of Trusses by Stiffness Method

Coordinate Transformations
Assembly of Global Stiffness Matrices
Introduction of Boundary Conditions
Solution and Properties of Global Stiffness Matrix

4. Structural Analysis of Frame Elements by Stiffness Method
   Derivation of Stiffness Coefficients for Bending
   Element Stiffness Matrices for Frame Elements
   Coordinate Transformations
   Element Loads and Equivalent Nodal Loads
   Shear and Torsional Deformations

5. Finite Element Analysis of 2D and 3D structures
   Introduction to Finite Element Methods and Principle of Virtual Displacements
   Shape Functions
   Derivation of Truss, Frame and Continuum Elements
   Solution of Finite Element Analysis for Continuum Structures

6. Nonlinear Structural Analysis
   Introduction and Applications
   Derivation of Geometric Stiffness Matrices and Solution of Problems with Geometric Stiffness
   Stability Analysis
   Description of Material Nonlinearities

Comments

I am always happy to meet with you to discuss your progress in the course or suggestions for how the class can be improved. Please feel free to stop by during office hours or to schedule an alternative appointment. Also, be sure to speak up in class if you have questions or you think I've made a mistake – its likely someone else has the same question!

Other Policies

(1) If you qualify for accommodations because of a disability, please submit to me a letter from Disability Services in a timely manner so that your needs may be addressed. Disability Services determines accommodations based on documented disabilities. Contact: 303-492-8671, Willard 322 and www.colorado.edu/disabilityservices.
(2) Campus policy regarding religious observances requires that faculty make every effort to reasonably and fairly deal with students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. If you have a concern regarding any activity in this class, please notify me early in the semester so that we can make alternative arrangements.
(3) All students at the University of Colorado at Boulder are responsible for knowing and adhering to the academic integrity policy. Violations of this policy may include: cheating, plagiarism, aid of academic dishonesty, fabrication, lying, bribery and threatening behavior. All incidents of academic misconduct shall be reported to the Honor Code Council (honor@colorado.edu; 303-725-2273). Students who are found to be in violation of the academic integrity policy will be subject to both academic sanctions from the faculty member and non-academic sanctions (including but not limited

to university probation, suspension, or expulsion). Other information on the Honor Code can be found at http://www.colorado.edu/policies/honor.html. The bottom line is that your work (your calculations, your writing, etc.) should represent **your own work** and not borrow language from anyone else without proper citation.

(4) The University of Colorado at Boulder policy on Discrimination and Harassment (http://www.colorado.edu/policies/discrimination.html), Sexual Harassment and Amorous Relationships applies to all students, staff and faculty. Any student, staff or faculty member who believes s/he has been the subject of discrimination or harassment based on race, color, national origin, sex, age, disability, sexual orientation or veteran status should contact the Office of Discrimination and Harassment (ODH) at 303-492-2127 or the Office of Judicial Affairs at 303-492-5550. Information about the ODH and the campus resources available to assist individuals regarding discrimination or harassment can be obtained at http://www.colorado.edu/odh.