University of Illinois at Urbana-Champaign
CEE 470 – Methods of Structural Analysis

Term: Fall Semester, 2024
12:00 pm – 1:50 pm Monday and Wednesday, Room 2311 Yeh Center, NCEL

Instructor: Professor Armando Duarte
Office: 2118 Newmark Civil Eng. Lab.
Office Hours: M 3:00-4:00 pm and W 4:00-5:00 pm on Zoom (Check Canvas "Zoom Meeting" for links and recordings)
E-mail: caduarte@illinois.edu

TA: Not available currently
E-mail:
Office Hours:

Web Site
Course material like class notes, handouts, and homework solutions are available from Canvas at this link https://courses.grainger.illinois.edu/CEE470 or at https://canvas.illinois.edu/

Course announcements will also be posted on Canvas — *Please check your spam filter for messages from Canvas.*

Online Lectures and Forum
- Recordings of lectures are available at Illinois Media Space: https://mediaspace.illinois.edu/
- Class attendance is expected and will enrich your course experience. If class attendance drops to less than 70%, access to these recordings will be restricted to students enrolled in ONL or ONC sessions.
- A discussion forum for this course is hosted on Piazza: https://piazza.com/illinois
    - Signup at https://piazza.com/illinois/fall2024/cee470

Course Objectives
1. Develop a thorough understanding of the direct stiffness method (DSM) of analysis -- Assumptions, limitations, and computational implementation.
2. Become more familiar with the modeling process - idealization of real structural systems into mathematical models that can be numerically solved.
3. Introduce the finite element method with applications to truss and beam elements.

Course Text
No textbook is required. Selected chapters from the first reference below are used.

References
- C. A. Felippa, Introduction to Finite Element Methods. A pdf copy is available on Canvas.
- D. L. Logan, A First Course in the Finite Element Method, Brooks Cole, Pacific Grove, CA, 2001. Any edition.
- A. Kassimali, *Matrix Analysis of Structures.* Brooks Cole, New York, 1999.

Course Content

1. Introduction
   a. Objectives.
   b. Model based simulation using the Direct Stiffness Method (DSM) and the Finite Element Method (FEM).
   c. Vector review.
   d. Matrix algebra and computations review.
   e. Coordinate transformations.

2. Fundamentals of the Direct Stiffness Method: Analysis of 2-D and 3-D Truss Systems
   a. 1-D bar element.
   b. Interpretation of element and structure stiffness coefficients.
   c. 2-D truss element and coordinate transformations.
   d. Globalization: Assembly and solution.
   e. Imposition of displacement boundary conditions.
   f. Thermo-mechanical effects.
   g. Putting the pieces together: Analysis of a truss using MATLAB.
   h. Additional topics: Mechanisms and eigenvalue analysis.
   i. Additional topics: Betti's law and Contra-gradient transformations.
   j. Analysis of space trusses.

3. Analysis of Framed Structures
   a. Torsion element.
   b. Beam element.
   c. Plane frames.
   d. Coordinate transformations and plane frames.
   e. Structural symmetry – load symmetry and anti-symmetry.
   f. Modified frame stiffness – releases.
   g. Static condensation

4. Finite Element Equations from the Principle of Virtual Work (PVW)
   a. PVW for a bar.
   b. The Galerkin method
   c. Finite element approximations for a bar
   d. Convergence of finite element approximations
   e. PVW for a beam.
   f. Finite element approximations for the Euler-Bernoulli beam

Grading Components

		w/ TA	w/out TA
Homework Assignments		20.0%	5.0%
Exam 1	Wednesday, Oct 16, 12:00pm-1:50 pm	22.5%	27.5%
Exam 2	Wednesday, Nov 13, 12:00pm-1:50 pm	22.5%	27.5%
Final Exam	Friday, Dec 19, 1:30pm-4:30 pm	35.0%	40.0%

Exam policy
All exams are closed books and notes. Information about exam logistics will be given later.
The final exam is comprehensive. Make-up exams will be given only under special circumstances *and by prior arrangement with the instructor.*

Assignments

- Homework assignments will be handled by Gradescope: https://www.gradescope.com/
  - Join Gradescope using invitation e-mail or use Entry Code EVEZ5D (login to the Gradescope website with your Illinois email and add yourself to the course with the course entry code).
  - Solve assignments using a tablet/iPad or scan your solution using an app like https://www.camscanner.com/
  - You can also scan and upload your assignments using the Gradescope app: https://guides.gradescope.com/hc/en-us/articles/22016028459789-Using-the-Gradescope-Mobile-App-for-Students
  - Submitted assignments must be in PDF.
  - Please check the quality of the PDF: I can only grade/check what I can see.
  - Upload your assignment to Gradescope before the deadline.
  - *Please map the assignment problems to pages of the PDF file when uploading it.*

- There will be about one assignment per week. Graded assignments will be available on Gradescope the following week.
- Solutions are posted on Canvas shortly after the due dates.
- Requests for regrading assignments (if applicable) and exams must be submitted within one week after they are returned. Submit requests at Gradescope.
- Homework is individual.
- The due dates for each assignment are given on the assignment sheet.
- No credit will be given for assignments that are submitted late.
- The assignment with the lowest grade will be dropped.

- You are encouraged to present your assignment in a professional, organized format.
- Don't just give a big list of equations—please explain your work.
- Don't skip steps in your procedures—please show all your work.
- Highlight answers by boxing or underscoring.
- If you are using Matlab or similar software, please don't just write down the final results—show the command files and/or the output listings. Additional guidelines may be given in the problem statement.

Matlab

Matlab is used in this course. There are links to tutorials on Matlab at the Canvas web site of this course.

UIUC Honor Code
The University of Illinois at Urbana-Champaign requires all students to adhere to the Student Honor Code (http://www.admin.uiuc.edu/policy/code/index.html)

CEE Honor Code
To foster and promote integrity among students, the CEE Honor Code was developed with input from several CEE undergraduate organizations, the CEE Graduate Student Advisory Committee, and the CEE Graduate Affairs Committee. You (the student) commit to honor the code each time you sign an exam, and implicitly whenever you sign homework or other class assignments.

The CEE Honor Code pledge is the following:

I pledge to uphold the highest levels of professional and personal integrity in all of my actions, including 1) never assisting or receiving unfair assistance during exams, 2) never assisting or receiving assistance on class assignments beyond that specified by an instructor, and 3) always fully contributing to group activities that are part of a course activity.

Safety Information Resources
The next page contains safety information provided by UIUC Division of Public Safety. You are also encouraged to watch this two-minute video: http://police.illinois.edu/emergency-preparedness/run-hide-fight/

Run > Hide > Fight

Emergencies can happen anywhere and at any time. It is important that we take a minute to prepare for a situation in which our safety or even our lives could depend on our ability to react quickly. When we're faced with almost any kind of emergency – like severe weather or if someone is trying to hurt you – we have three options: Run, hide or fight.

Run

Leaving the area quickly is the best option if it is safe to do so.

- Take time now to learn the different ways to leave your building.
- Leave personal items behind.
- Assist those who need help, but consider whether doing so puts yourself at risk.
- Alert authorities of the emergency when it is safe to do so.

Hide

When you can't or don't want to run, take shelter indoors.

- Take time now to learn different ways to seek shelter in your building.
- If severe weather is imminent, go to the nearest indoor storm refuge area.
- If someone is trying to hurt you and you can't evacuate, get to a place where you can't be seen, lock or barricade your area if possible, silence your phone, don't make any noise and don't come out until you receive an Illini-Alert indicating it is safe to do so.

Fight

As a last resort, you may need to fight to increase your chances of survival.

- Think about what kind of common items are in your area which you can use to defend yourself.
- Team up with others to fight if the situation allows.
- Mentally prepare yourself – you may be in a fight for your life.

Please be aware of people with disabilities who may need additional assistance in emergency situations.

Other resources

- **police.illinois.edu/safe** for more information on how to prepare for emergencies, including how to run, hide or fight and building floor plans that can show you safe areas.
- **emergency.illinois.edu** to sign up for Illini-Alert text messages.
- **Follow the University of Illinois Police Department** on Twitter and Facebook to get regular updates about campus safety.