ME 471 / AE 420 / CSE 451: Finite Element Analysis

Spring 2026

Instructor:	Brian Mercer	**Time:**	MW 12:00pm – 1:20pm
Email:	bmercer@illinois.edu	**Place:**	114 Transportation Building

Course Web Pages:

1. Canvas - Syllabus; assignments and due dates; lecture notes; etc.
2. Gradescope - Written homework submission
3. PrairieLearn - Autograded homework problems are hosted here
4. Campuswire - Online forum for communication with course staff

Teaching Assistants:

1. Pavan Ravi, pavanr2@illinois.edu
2. Mahmuda Arshee, marshee2@illinois.edu

Office Hours: Instructor and TA office hours will be listed on the Canvas course page.

Credit: 3 or 4 undergraduate hours; 4 graduate hours. Students seeking the additional hour will be assigned extra requirements or work on homework and/or projects.

Textbook: There is no required textbook for this class. Recommended references are listed below:

1. R. D. Cook, D. S. Malkus, M. E. Plesha, R. J. Witt, *Concepts and Applications of Finite Element Analysis*, 4th edition, John Wiley & Sons, 2002.
2. K. H. Huebner, D. L. Dewhirst, D. E. Smith, T. G. Byron, *The Finite Element Method for Engineers*, 4th edition, John Wiley & Sons, 2001.
3. T. J. R. Hughes, *The Finite Element Method: Linear Static and Dynamic Finite Element Analysis*, Dover, 2000.

Prerequisites: CS 101 and ME 371 or TAM 470. Alternatively, AE 370 for AE students..

Course Learning Objectives: After completing the course, students will:

1. Understand the mathematical theory and foundation of the finite element method for linear differential equations.
2. Be able to write computer subroutines and/or full programs to carry out key finite element computations involving heat transfer and linear elasticity.

3. Be able to use commercial FEA software to model and solve complex engineering problems in heat transfer and linear elasticity.

Course topics:

1. Direct approach to finite element method, applications to spring and truss problems.
2. Weighted residual and variational formulation approaches.
3. Review of common element types for 1D, 2D and 3D analyses; isoparametric element formulations; beam elements.
4. Finite element formulations for solving steady-state and transient heat transfer problems.
5. Finite element formulations for solving static and transient problems in linear elasticity.
6. Modal (frequency) analysis for linear elastic structures.
7. FEM error behavior.
8. Computer programming implementation of finite element analysis: concepts and applications.
9. Use and applications of Abaqus commercial FEA software.
10. Special topics (time permitting): Nonlinear FEA, contact mechanics, plate and shell elements, engineering industry case studies and practical applications.

Grading Scheme: The final course grade is assessed based on your scores in the following categories:

1. Homework (35%)
2. Projects (20%)
3. Midterm exam (15%)
4. Final Exam (30%)

The total score s corresponds to the final letter grade as follows:

$97\% \leq s \leq 100\%$	A+	$93\% \leq s < 97\%$	A	$90\% \leq s < 93\%$	A-
$87\% \leq s < 90\%$	B+	$83\% \leq s < 87\%$	B	$80\% \leq s < 83\%$	B-
$77\% \leq s < 80\%$	C+	$73\% \leq s < 77\%$	C	$70\% \leq s < 73\%$	C-
$67\% \leq s < 70\%$	D+	$63\% \leq s < 67\%$	D	$60\% \leq s < 63\%$	D-
$s < 60\%$	F				

Homework:

1. In this course, you are allowed to discuss homework assignments with other students, form study groups, etc, **but all submitted work and code must be your own**.
2. All problems on a given homework assignment must be submitted through the required platform (Gradescope or PrairieLearn) by the indicated due date to be considered for full credit.
3. The schedule of homework due dates will be maintained on the Canvas course page.
4. The Homework grade category for your final course grade is calculated as

$$\frac{\text{(total points earned)}}{\text{(total points available)}} \times 100\%,$$

   Note that individual homework assignments are <u>not</u> weighed equally towards your final grade calculation. The relative weight of an assignment depends on how many points the assignment is worth and is generally proportional to the workload required to complete the assignment.

Projects:

1. Unlike Homework assignments, Projects should be treated like a take-home exam, and **students are not permitted to work together or discuss their work on Projects; these must be fully individual efforts.**
2. There will be **two** projects assigned in the class. Project due dates will be maintained on Canvas.
3. Projects are weighted equally in terms of their contribution to your overall grade.

Homework and Project late submission policy: Late Homework and Project submissions will be penalized 10% per day (24 hour period), up to 2 days (48 hours) late. After 48 hours beyond the original due date have passed, the assignment will receive a zero. Please carefully review the rules below regarding extension requests for Homeworks and Projects:

1. All extension/make-up work requests must be received **in advance of the due date** or they will not be considered. You may request a homework or project deadline extension for the following situations, and must also provide appropriate documentation:
   - Short illness (requires doctor's note with specific days to be excused from class).
   - Illness for 3 or more days (requires letter from the Dean of Students)
   - Personal crisis (e.g., car accident, required court appearance, death of a close relative).
   - Required attendance at an official UIUC activity (e.g., varsity athletics, band concert).
   - For more extreme situations that involve an extended absence for more than a few days, please contact the instructor as soon as possible so we can discuss how to proceed.
2. Note that regardless of documentation provided, the final decision to grant an extension always lies with the instructor.
3. Your lowest **submitted** homework assignment score will be dropped. Project scores cannot be dropped.

Exams: There are two exams in the course:

1. Midterm: In class on Wednesday March 4, 2026.
2. Final: Friday May 8, 2026 from 1:30pm to 4:30pm, location TBD.

Class attendance and participation: Class time will consist of a mixture of lectures, FEA computer labs, and in-class activities (solving example problems, group/classroom discussions, etc.). Regular attendance and participation in class activities is expected.

Communication: Please use Campuswire for **all** communication with the instructor or TAs in this course. This ensures that you get a timely response to your issue. Please follow these guidelines:

1. For private/personal questions e.g. requesting an assignment extension or requesting use of DRES accommodations, post to "Instructor & TAs".
2. Post conceptual/homework help questions to "Everyone" (rather than just "Instructor & TAs"), even if anonymously, so that everyone can benefit from the answer.
3. Anyone, including fellow students, is welcome to answer a publicly posted question.
4. Do not make posts to "Everyone" about homework/programming problems you are working on that contain the entire written or code solution. Such posts will be deleted.

Software: You will need access to the following software in this class:

1. Python: All coding assignments in the course must be completed using Python. Information regarding installing/accessing Python can be found on the Canvas course page.
2. Abaqus: We will use the FEA software Abaqus for some in-class lab sessions and assignments. You can use Abaqus in EWS labs or you can install on your personal computer, see getting an educational license through the UIUC WebStore.

Academic integrity: Every student is expected to review and abide by the university's Academic Integrity Policy as outlined in the Student Code. It is your responsibility to read this policy to avoid any misunderstanding. Ignorance is not an excuse. Do not hesitate to ask the instructor if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity.

Use of Generative AI: Generative AI, such as ChatGPT, Microsoft Copilot, and Gemini, can answer questions and generate text, images, and other media. In this course, there are times when generative AI may be useful. If you choose to use generative AI as permitted below, you must document and attribute all AI contributions to your coursework and take full responsibility for the contributions including the accuracy of the information and reliability of sources. When using generative AI, keep a journal documenting prompts, AI responses, and your usage. Your instructor may ask you to provide this documentation.

In this course, you may use generative AI for the following:

1. Revising your own text for spelling and grammar.

2. Creating study aids for exams.
3. Testing and practicing your knowledge of course topics.
4. Getting help with learning how to do a particular action or access a particular setting in Abaqus.
5. Getting help with small code tasks, such as correct structuring of a "for" loop or seeking help with performing operations on `numpy` arrays.
6. Debugging code, for example, helping to identify and fix syntax errors or interpreting error messages.

You MAY NOT use generative AI for the following:

1. Writing entire sentences, paragraphs, or papers to complete class assignments.
2. Generating large blocks of code for assignments that require Python code as part of the solution or solution process.
3. Generating full or partial solutions to problems that must be solved as part of homework or project assignments.

If you have a question about the use of Generative AI, please reach out to your instructor. **Failure to abide by these guidelines is a violation of academic integrity.**

Online Section (ONL): The online section of this course is conducted as described in the syllabus sections above, with the following additions and modifications:

1. Lecture sessions will be made available as asynchronous recordings, posted soon (generally same-day) after the live class meeting has concluded. A link to the UIUC Mediaspace channel hosting the video lectures will be maintained on the Canvas course page.
2. Office hours are offered over Zoom by appointment, with either the instructor or TA. Please send us an email if you would like to meet, and we can work together to schedule a time.
3. You are responsible for owning or having access to a computer that can support the software that we will be using in this course. Abaqus, in particular, is a resource-intensive program and may not run smoothly on older computers, so please plan accordingly and aim to install and test the software early in the semester.