ME 538: Introduction to Finite Element Methods and Analysis

Fall 2023

Instructor and Class Information

Instructor: Dr. Harold Park, Professor of Mechanical Engineering
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Phone: (617) 353-4208
Office Hours: Tuesdays 11-12
Class Hours: MW 10:10-11:55
Classroom: Lectures will be held in EPC 208, Ansys labs will be held in EMB 125 (to get here, go in the 5 St. Mary's entrance and walk all the way down the long hallway)
Prerequisites: ME305, Linear Algebra, Ordinary Differential Equations
Course Website: Blackboard (`http://learn.bu.edu`)

TA Information

TBD

Course Summary

This class serves as an introduction to the linear finite element method, and its application to static and dynamic problems with an emphasis on solid mechanics. The first half of the course will use the stiffness approach to developing the finite element equations as applied to bars and beams. The second half of the course will focus on developing the finite element method as one that is applicable as a general numerical method for solving ordinary and partial differential equations that arise in solid mechanics. Lab sessions will focus on applying the commercial code Ansys to various problems in solid mechanics.

Textbook (Recommended)

A first course in the finite element method by Daryl L. Logan, sixth edition, Cengage 2017

Reference Books

- *Concepts and applications of finite element analysis* by R.D. Cook, D.S. Malkus, M.E. Plesha and R.J. Witt, fourth edition, Wiley 2002

Class Policies

- Homework (i.e. labs, written homeworks, and matlab projects) not turned in by the end of class (i.e. 12 PM) on the due date will be considered to be late. **No credit for late homeworks, labs or programming assignments will be given.**

- There will be some written homework assignments. Homework problems should be well-organized while demonstrating a clear flow of thought and worked-out steps. Homework problems will be graded on a 10/7/0 scale. A score of 10 indicates that you worked through the entire problem and came to a correct or mostly correct solution. A score of 7 indicates that you made a solid attempt and a 0 will be given for a minimal attempt or lack thereof.
- There will be ANSYS and Matlab-based programming assignments throughout the semester. There will not be a final exam.
- Making up of missed examinations or assignments will be permitted only when proof of medical or personal emergency is furnished.
- All complaints related to grading of homework assignments, quizzes, and examinations must be reported to the instructor within one week of when the grades are posted to Blackboard.

Academic Misconduct

BU takes academic integrity very seriously. Academic misconduct is conduct by which a student misrepresents his or her academic accomplishments, or impedes other students opportunities of being judged fairly for their academic work. Knowingly allowing others to represent your work as their own is as serious an offense as submitting anothers work as your own. More information on BU's Academic Conduct Code, with examples, may be found at `http://www.bu.edu/academics/policies/academic-conduct-code`

Accommodations for Students with Documented Disabilities

If you are a student with a disability or believe you might have a disability that requires accommodations, requests for accommodations must be made in a timely fashion to Disability & Access Services, 25 Buick St, Suite 300, Boston, MA 02215; 617-353-3658 (Voice/TTY). Students seeking academic accommodations must submit appropriate medical documentation and comply with the established policies and procedures `http://www.bu.edu/disability/accommodations/`

Absence for Religious Reasons

According to Chapter 151C of the General Laws, Commonwealth of Massachusetts, any student in an educational or vocational training institution, other than a religious or denominational educational or vocational training institution, who is unable, because of his or her religious beliefs, to attend classes or to participate in any examination, study, or work requirements on a particular day, shall be excused from any such examination or study or work requirement, and shall be provided with an opportunity to make up such examination, study, or work requirement that may have been missed because of such absence on any particular day. More details can be found here: `https://www.bu.edu/academics/policies/absence-for-religious-reasons/`

Approximate List of Topics to be Covered

Stiffness (displacement) method for bars and beams, matrix methods, governing differential equation for solids (strong form), weak form, discretization of weak form using the finite element approximation, shape functions, numerical quadrature, isoparametric elements, dynamic analysis, heat transfer, mass transfer, multi-dimensional finite elements, nonlinear finite elements.

Using Generative AI in Coursework

See `https://www.bu.edu/cds-faculty/culture-community/gaia-policy/`. Specifically, students shall:

- Give credit to AI tools whenever used, even if only to generate ideas rather than usable text or illustrations.
- When using AI tools on assignments, add an appendix showing (a) the entire exchange, highlighting the most relevant sections; (b) a description of precisely which AI tools were used (e.g. ChatGPT private subscription version or DALL-E free version), (c) an explanation of how the AI tools were used (e.g. to generate ideas, turns of phrase, elements of text, long stretches of text, lines of argument, pieces of evidence, maps of conceptual territory, illustrations of key concepts, etc.); (d) an account of why AI tools were used (e.g. to save time, to surmount writers block, to stimulate thinking, to handle mounting stress, to clarify prose, to translate text, to experiment for fun, etc.).
- Use AI tools wisely and intelligently, aiming to deepen understanding of subject matter and to support learning.
- Employ AI detection tools and originality checks prior to submission, ensuring that their submitted work is not mistakenly flagged.

The instructor shall:

- Seek to understand how AI tools work, including their strengths and weaknesses, to optimize their value for student learning.
- Treat work by students who declare no use of AI tools as the baseline for grading.
- Use a lower baseline for students who declare use of AI tools, depending on how extensive the usage, while rewarding creativity, critical nuance, and the correction of inaccuracies or superficial interpretations in response to suggestions made by AI tools.
- Employ AI detection tools to evaluate the degree to which AI tools have likely been employed.
- Impose a significant penalty for low-energy or unreflective reuse of material generated by AI tools and assigning zero points for merely reproducing the output from AI tools.

Grading

- Written homeworks: 15%
- Matlab homeworks: 40%
- Ansys Labs: 25%
- Final Matlab homework: 20%