MECH 462-514
Finite Element Analysis

Syllabus:

Contact Information

Professor: Mattia Bacca
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TA: Zhiyuan (Ryan) Tong
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*Office hours might be adjusted to match the students' needs based on their time zone. Additional office hours will be available on demand for extenuating circumstances like different time zone, technical issues and/or logistic issues. In such cases, simply contact the TA or Instructor to schedule a meeting.

Course website: Canvas

Class Format

Lectures:	Tue	11 - 12.30	Online
	Thu	11 - 12.30	Online
Tutorials:	Thu	11 - 12.30	Online

Class format: Zoom lectures. The Zoom lectures will be recorded via Zoom Cloud. The links to the recorded video lectures will be posted on Canvas.

This course is delivered online for the first time. We thank the students in advance for their patience and cooperation. Together we will make this course exciting, fun and useful.

The students will be provided blank notes to be filled during class. After the class, the students will be provided a summary of the main content so that everyone can double-check nothing was missed. However, the summary notes alone will be insufficient to cover the content of the course, hence each student is expected to diligently attend class.

Weekly assignments will be posted on Canvas for the students to complete. The assignments will include exercises involving coding in Matlab, as well as exercises that will serve as practice for midterms and final. The Matlab coding will simply involve taking a code from the posted ones on Canvas and modify it to solve the assignment task. The completion of the assignments must be done by the deadline. The diligent completion of the assignments will count 5% toward the final grade. If students do not submit their assignment in time or completely miss a submission, that will be curtailed from the 5% grade weight. The solution to the assignment will be posted after the deadline and solved during the Tutorials. The Tutorials will mostly include practical lectures on the use of Abaqus, but might include the solution the assignments and/or additional sample problems (that serve as practice for midterms and finals).

Pre-requisites

MECH 360, MECH 375.

Learning objectives

The students will be able to:

1. Understand the *mathematical principles* behind the *Finite Element Method*: A numeric strategy to solve partial differential equations (PDEs).
2. Develop a simple FE code in Matlab for *solving truss structures* and *continuum structures*.
3. Use the commercially available software Abaqus, which serves as a foundation for the use of other software like ANSYS, Comsol, etc.

Course Assessment

Weekly assignments:	5% (Online)
Midterm:	20% (Online), **date: February 25, 2021**
Final Exam:	40% (Online)
Project:	35% (Online submission), **dates:**
	Project discussion, by Feb. 1st, 2021
	1st submission, March 31st, 2021
	Final submission, April 25th, 2021

Course Schedule

Week	***Module***

1	**1. Introduction & The stiffness matrix** - *Recap of tensorial algebra (matrices and vectors)* - *Static determination of the elastic problem and matrix singularity*
1-4	**2. Truss structures** - *Solution of truss structures with the Finite Element Method in 2D, quasi-static analysis* - *Truss structures in 3D* - *Truss structures in 2-3D, dynamic analysis*
5	**3. Frame structures** - *Basic frame structures in 2D, quasi-static analysis*
6-10	**4. Finite Element Analysis in Continuum Mechanics (Continuum Structures)** - *Principle of virtual work: energetic analysis of the elastic problem* - *Strong form and weak form of field equations* - *Boundary conditions* - *Shape functions* - *Quasi-static analysis* - *Dynamic analysis*
11-13	**5. Finite Element Analysis in Continuum Thermodynamics** - *Heat conduction in the continuum* - *Strong form and weak form of field equations* - *Boundary conditions* - *Shape functions* - *Quasi-static analysis* - *Dynamic analysis* - *FEA in Physical chemistry: mass transport and reactions*

Textbooks

Course book:

[1] T.R. Chandrupatla, A.D. Belegundu, “Introduction to finite elements in engineering”, Prentice-Hall.

Additional resources:

[2] M.S. Gadala, “Finite Elements for Engineers with Ansys Applications”, Cambridge University Press.
[3] T.J.R. Hughes, “The Finite Element Method: Linear Static and Dynamic Finite Element Analysis”, Dover Publications.
[4] J.N. Reddy, “An Introduction to the Finite Element Method”, McGraw-Hill Education.