

ME-473

Dynamic finite element analysis of structures

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Cursus	Sem.	Type
Mechanical engineering	MA2, MA4	Opt.

Language of teaching	English
Credits	3
Session	Summer
Semester	Spring
Exam	Written
Workload	90h
Weeks	14
Hours	3 weekly
Lecture	2 weekly
Exercises	1 weekly
Number of positions	

Summary

The course focuses on the numerical analysis of 3D structures using the finite element method in the context of linear elasticity. Students will gain proficiency in numerical techniques widely employed in static and dynamic structural analysis, and apply these methods to address real-world problems.

Content

- Strong and weak forms of the governing equations of motion and equilibrium for deformable solids.
- Finite element method applied to three-dimensional dynamic structural problems.
- Development of solid and shell finite elements.
- Strain matrix, local and global coordinate systems, and assembly of local elements.
- Development of modal parameter extraction methods.
- Numerical analysis of the free and forced regimes.
- Examples and case studies in MATLAB.

Keywords

Finite element, weak form, strong form, modal analysis, numerical methods.

Learning Prerequisites**Required courses**

Mechanics:

- Mechanics of structures (for GM)
- Mechanical vibrations
- Solid mechanics

Numerics:

- Numerical analysis
- Finite element method

Recommended courses

Finite element modelling and simulation

Learning Outcomes

By the end of the course, the student must be able to:

- Derive a finite element formulation from the differential equations in strong form.
- Develop a critical awareness of the sources of errors inherent to the FE modelling practice.
- Use appropriate modelling and simulation techniques to solve a complex physical problem.
- Solve structural dynamics problems by using modal analysis.

Transversal skills

- Use both general and domain specific IT resources and tools
- Plan and carry out activities in a way which makes optimal use of available time and other resources.
- Use a work methodology appropriate to the task.
- Write a scientific or technical report.

Teaching methods

Ex cathedra lectures, exercises in the classroom and computer lab sessions.

Expected student activities

Attendance in class.

Solving theoretical problems presented in exercise series.

Solving practical problems with the help of a computer.

Assessment methods

40% mini-projects during the semester and 60% final written exam

Supervision

Office hours	Yes
Assistants	Yes
Forum	Yes

Resources

Bibliography

- Thomas Gmür, Méthode des éléments finis en mécanique des structures, Presses polytechniques et universitaires romandes (PPUR), Lausanne, 2018, ISBN 978-2-88915-158-5.
- Thomas Gmür, Dynamique des structures - analyse modale numérique, Presses polytechniques et universitaires romandes (PPUR), Lausanne, 2014 (2ème édition), ISBN 978-2-88074-813-5
- Thomas J. R. Hughes, The Finite Element Method - Linear Static and Dynamic Finite Element Analysis, Prentice-Hall, Englewood Cliffs, NJ, 1987 (Dover Publications, 2000), ISBN 978-0-48641-181-1

Moodle Link

- <https://go.epfl.ch/ME-473>