ME-473

Dynamic finite element analysis of structures

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Cursus	Sem.	Type
Mechanical engineering minor	H	Opt.
Mechanical engineering	MA1, MA3	Opt.

Language of teaching	English
Credits	3
Session	Winter
Semester	Fall
Exam	Oral
Workload	90h
Weeks	14
Hours	**3 weekly**
Courses	2 weekly
Exercises	1 weekly
Number of positions	

Summary

The course focuses on the dynamic 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, Beam and shell elements, Structural dynamics, Subspace method, Newmark 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:

- Apply the concepts of structural dynamics to predict the vibratory behaviour, free or forced, conservative or damped, of continuous systems. (S3)
- Derive a finite element formulation of a physical problem from its strong-form using the principle of virtual work or a variational approach. (S9)
- Implement the theoretical concepts of the finite element method to carry out a complete study of a real-world problem based on a project specification, and provide a critical analysis of the results obtained. (S10)

Transversal skills

- Use both general and domain specific IT resources and tools
- Assess one's own level of skill acquisition, and plan their on-going learning goals.
- Make an oral presentation.
- Plan and carry out activities in a way which makes optimal use of available time and other resources.

Teaching methods

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

Expected student activities

Attendance in class.
Solving theoretical and practical problems presented in exercise series.
Complete of several mini-projects.
Write scientific reports.

Assessment methods

50% mini-projects during the semester and 50% final oral exam.

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

Ressources en bibliothèque

- Find the references at the Library

Moodle Link

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