MATH-468

Numerics for fluids, structures & electromagnetics

Cursus	Sem.	Type
Computational science and Engineering	MA2, MA4	Opt.
Ing.-math	MA2, MA4	Opt.
Mathématicien	MA2	Opt.

Language of teaching	English
Credits	5
Session	Summer
Semester	Spring
Exam	Oral
Workload	150h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	2 weekly
Number of positions	

Remark

pas donné en 2020-21

Summary

The aim of the course is to give a theoretical and practical knowledge of the finite element method for saddle point problems, such as fluid dynamics, elasticity and electromagnetic problems.

Content

Keywords

Partial differential equations, saddle point problems, finite element method, Galerkin approximation, stability and convergence analysis.

Learning Prerequisites

Required courses

Analysis I II III IV, Numerical Analysis, Advanced numerical analysis, Sobolev spaces and elliptic equations, Numerical Approximations of PDEs

Important concepts to start the course

- Basic knowledge of functional analysis: Banach and Hilbert spaces, L^p spaces.
- Some knowledge on theory of PDEs: classical and weak solutions, existence and uniqueness.
- Basic concepts in numerical analysis: stability, convergence, condition number, solution of linear systems, quadrature formulae, finite difference formulae, polynomial interpolation.
- Basic information on finite element theory for elliptic problems

Learning Outcomes

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

- Identify features of a PDE relevant for the selection and performance of a numerical algorithm.
- Assess / Evaluate numerical methods in light of the theoretical results.
- Implement numerical methods for saddle point problems
- Choose an appropriate method to solve a given differential problem

- Prove convergence of a discretisation scheme

Transversal skills

- Write a scientific or technical report.

Teaching methods

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

Expected student activities

- Attendance of lectures.
- Completing exercises.
- Solving problems with an academic software as Free FEM ++

Assessment methods

Oral exams and evaluation of the report of a mini-project.

Supervision

Office hours	Yes
Assistants	Yes
Forum	No

Resources

Bibliography

- S.C. Brenner, L.R. Scott. *The Mathematical Theory of Finite Element Methods*. Springer 2007.
- A. Ern, J-L. Guermond, *Theory and Practice of Finite Elements.* Springer 2004.
- D. Boffi, F. Brezzi, M. Fortin *Mixed Finite elements and Applications*, Springer Verlag. 2013.

Ressources en bibliothèque

- The Mathematical Theory of Finite Element Methods / S.C. Brenner & L.R. Scott
- Mixed Finite elements and Applications / D. Boffi, F. Brezzi & M. Fortin
- Theory and Practice of Finite Elements / A. Ern & J-L. Guermond

Notes/Handbook

Notes for each lectures will be provided every week.