MATH-468

# Numerics for fluids, structures & electromagnetics

| Cursus | Sem. | Type |
|---|---|---|
| Computational science and Engineering | MA1, MA3 | Opt. |
| Computational science and engineering minor | H | Opt. |
| Ing.-math | MA1, MA3 | Opt. |
| Mathématicien | MA1, MA3 | Opt. |
| Nuclear engineering | MA1 | Opt. |

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|---|---|
| Language of teaching | English |
| Credits | 5 |
| Session | Winter |
| Semester | Fall |
| Exam | Oral |
| Workload | 150h |
| Weeks | 14 |
| **Hours** | **4 weekly** |
| Lecture | 2 weekly |
| Exercises | 2 weekly |
| **Number of positions** | |

## Remark

Pas donné en 2024-25. Cours donné en alternance tous les deux ans.

## Summary

Cours donné en alternance tous les deux ans

## 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,  Numerical Approximations of PDEs

### Recommended courses

Sobolev spaces and elliptic equations,

### 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.
- Make an oral presentation.

### 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

### Supervision

| | |
|---|---|
| Office hours | Yes |
| Assistants | Yes |
| Forum | Yes |

### 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
- Theory and Practice of Finite Elements / A. Ern & J-L. Guermond
- Mixed Finite elements and Applications / D. Boffi, F. Brezzi & M. Fortin

#### Notes/Handbook

Notes for each lectures will be provided every week.

#### Moodle Link

- https://go.epfl.ch/MATH-468

#### Videos

- http://Recording of the lectures will be provided after each lecture.