

MATH-468

**Numerics for fluids, structures & electromagnetics**

Buffa Annalisa

Cursus	Sem.	Type
Computational science and Engineering	MA1, MA3	Opt.
Ing.-math	MA1, MA3	Opt.
Mathématicien	MA1, MA3	Opt.

Language of teaching	English
Credits	5
Session	Winter
Semester	Fall
Exam	Oral
Workload	150h
Weeks	14
<b>Hours</b>	<b>4 weekly</b>
Courses	2 weekly
Exercises	2 weekly
<b>Number of positions</b>	

**Remark**

Cours donné en alternance tous les deux ans

**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 the ones of 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, 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.

### 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](#)
- [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.