2EL1760 – Scientific calculation

Instructors: Hachmi Ben Dhia
Department: DÉPARTEMENT MATHÉMATIQUES
Language of instruction: FRANCAIS
Campus: CAMPUS DE PARIS - SACLAY
Workload (HEE): 60
On-site hours (HPE): 35,00
Elective Category : Fundamental Sciences
Advanced level : Yes

Description
The course is both a rigorous and applied brick, contributing to the design of complex mechanical systems through modeling, mathematical analysis, approximation and controlled simulations of engineering problems in solids and fluid mechanics. This covers sectors such as Energy, transportation and aerospace.

The educational goal is that students following this course gain a good understanding of the chain integrating modeling, mathematical analysis and simulation for the study of such complex systems, trough simplified still relevant of solid and fluid mechanics.

Quarter number
SG8

Prerequisites (in terms of CS courses)
Basic knowledge in Continuum Mechanics: CM Hypotheses-Classical Mechanical Fields for Solids and Fluids-basic governing equations and meaning of these equations-Basic notions of differentiation and integration-Basic notions on Hilbert spaces and weak formulations of PDEs-Basic notions on stability and prime notions on space and time approximation schemes for PDEs. Roughly speaking : a first year CS level of knowledge in Mathematics and Mechanics or a third University year in Applied Mathematics to Mechanics.

Syllabus
The course is composed of two successive parts of 5,5 x 3h, each.

1. Compressible fluid flows simulation :
- Flow models, discontinuous solutions, Entropy, Basic solvers, extensions
- Practical implementation

2. Modeling, mathematical analysis and controlled simulation in solid mechanics
-Derivation of linear elasticity equations: strong and weak forms
-Mathematical analysis of the primal weak problem. Vectoriel Finite element approximation. A priori error estimation
-Practical implementation and approximation of a singular problem (as mini-project)

Class components (lecture, labs, etc.)
Classical Lectures, Tutorial, Projects

Grading
Written exam, oral exam, ProjectEvaluation (first session) : Written exam (coef 2), Project (coef 1)Evaluation (second session) : Oral or written exam

Course support, bibliography
- Handout PDEs (first CS year) and Handouts for the two parts (Fluid and Solid) of the course (and references therein)
- Matlab, Scilab, Python...

Resources

Hachmi Ben Dhia (Professeur des Universités, CentraleSupélec), Laboratoire MSSMat et Fédération de Math CS

Frédérique Laurent-Nègre (Chercheur CNRS), Laboratoire EM2C et Fédération de Math CS

External Assistants (PW, Projects)

Computer Rooms

Learning outcomes covered on the course

Some Basic mathematical methods and tools for the analysis of continuous problems of Mechanics of solids and fluids

Some Numerical methods for approximating continuous problems (Finite Difference, Finite Volume and Finite Element)

Estimation of errors between continuous and approximate solution and mathematical control of convergence.

Analysis of engineering problems governed by Partial Differential Equations (PDEs)

Practice of numerical simulation, taking into account the mathematical properties of these PDEs

Initiation to the best fit choice of the numerical methods

Description of the skills acquired at the end of the course

Analysis of engineering problems governed by Partial Differential Equations (PDEs)

Practice of numerical simulation, taking into account the mathematical properties of these PDEs

Initiation to the best fit choice of the numerical methods