Numerical methods in Mechanical Engineering

ECTS credits
2 credits

Semester
Spring

In brief

Course langage: French

Presentation

Prerequisites

- Basic numerical analysis courses (Bachelor level - 1st year course)
- 1st year Mechanical Engineering course

Learning objectives

- Initiate to the stakes of contemporary numerical simulation in terms of computation as well as the specificities of the equation models encountered in fluids, solids or acoustics.
- Make the link with general and basic notions seen in mathematics from a theoretical point of view and apply them in the context of mechanical engineering.
- Provide a global vision of numerical methods used in mechanics (solids, fluids):
  -- to be able to parameterize a basic calculation code based on classical discretization methods (finite elements, finite volumes)
  -- to be able to understand the specific methods encountered in the calculation codes for parameterization in fluids and solids.

Description of the programme

The specificities of the problems encountered in solid mechanics, fluid mechanics and acoustics will be emphasized and the different approaches used will be justified. The particularities related to numerical simulations of non-linear problems will be discussed. The difficulties related to the parameterization of industrial calculation tools will be highlighted. 8h will be dedicated to an initiation to a multiphysics simulation software.

- General considerations
  -- Current trends in computing resources, towards massively parallel computing

-- General principles of discretization schemes in time and space, convergence-stability-consistency, implicit and explicit schemes
-- Generalities on finite differences, finite elements, spectral methods, finite volumes, boundary elements

- Numerical methods in mechanics: an introduction to CFD
  -- Finite volume and finite element techniques in fluid
  -- The problem of incompressibility in fluids
  -- Application to the solution of the Navier-Stokes equations for an incompressible fluid
  -- Stabilized methods
  -- Simulation of turbulence in fluids
  -- Towards an enlightened use of industrial computational codes in fluids: the Ansys-Fluent case

- Numerical methods in mechanics: an introduction to the simulation of solids and structures
  -- Finite element code, finite element techniques, algorithmic framework
  -- Beyond elasticity: time schemes, nonlinear problems (time steps, iterations) total lagrangian approach

- Numerical methods in mechanics: an introduction to acoustics
  -- Finite elements in acoustics
  -- boundary integral method

- From CAD to computation: towards an integrated approach from design to simulation; application of the iso-geometric method to fluids and solids

- Practical applications in COMSOL Multiphysics: practical work on machines (8h)

Generic central skills and knowledge targeted in the discipline

- Ability to take into account basic physical problems to use industrial simulations tools
- Ability to build new software solutions to simulate complex phenomena not present in standard industrial codes
- Ability to understand a complex situation with multiple physics to propose efficient software solutions
- Ability to develop a reasonable use of the computational tools

How knowledge is tested

CC1: Report of the practical work (50%)
CC2: Home work in autonomy on a given subject (50%)

Bibliography

- Course support (in english)
- T.J.R. Hughes,The finite element method, éd.Prentice-Hall,1987
- A. Ibrahimbegovic, Nonlinear solid mechanics, Hermes,2009

• J.Wendt,Computational FluidDynamics, Springer, 2009

Teaching team

• Dominique Eyheramendy
• Part-time teachers for Practical Work

Total des heures		**24h**
CM	Master class	10h
TD	Directed work	6h
TP	Practical work	8h

Useful info

Name responsible for EU

Lead Instructor

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