INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

Models and numerical methods for solid and fluid mechanics

Introducing

Description

Program (detailed contents):

Fundamental concepts of continuum mechanics:

- Physical properties of fluids and solids.
- Lagrangian and Eulerian formulations
- Tensor of deformations, strain rates and stresses
- Derivation of the general equations of continuum mechanics

Modeling and scientific computing in fluid mechanics:

- Dynamics of viscous incompressible fluids
- Dynamics of incompressible perfect fluids, potential flows
- Introduction to the finite volume method (FVM) for incompressible viscous fluids
- Implementation in PYTHON of the FVM on a simple problem
- Use of the industrial software FLUENT to model and compute the solution of some 2D problems (driven cavity, flow around a wing profile)

Modeling and scientific computing in structural mechanics

- Variational formulation and relation with the energy minimization for the elasticity problem.
- Numerical solution of elasticity with the finite element method.
- Modeling and computation of static as well as dynamic elastic problems through the use of an industrial software (ABAQUS)
- Multiscale model and code coupling.
- Development of python routines for the computation of stress concentration and local propagation of cracks within solids
- Data-Driven Computational Mechanics
- Introduction of the concept and application on a 2D example of lattice.

Objectives

At the end of this module, the student will have understood and be able to explain (main concepts):

The fundamentals of Mechanics for fluid and deformable solids, from a physical, mathematical and numerical point of view.

The student will be able to:
- Know the main models used in continuum mechanics for fluids and solids
- Calculate exact solutions of simple problems and know how to interpret them physically
- Evaluate orders of magnitude
- Formulate and solve the dynamics of an incompressible flow using the finite volume method.
- Formulate and solve the problem of elasticity using the finite element method.
- Use an industrial software to model and compute the elasticity problem in both static and dynamic modes, and some fluid mechanics problems, for incompressible and compressible flows
- Write and implement a mixed formulation to couple different elastic domains and different numerical codes used as black-boxes.
- Apprehend the data-driven (model-free) paradigm in computational mechanics.

Necessary prerequisites

Fundamentals in:
- Mechanics (forces, Newton's laws, kinetic energy, potential energy)
- PDE course (finite element method in 1D, finite volume method in 1D)
- Analysis and electrostatic courses: Differential and integral calculus for functions of several variables (gradient, Jacobian, Ostrogradsky's theorem ...)

Évaluation

L'évaluation des acquis d'apprentissage est réalisée en continu tout le long du semestre. En fonction des enseignements, elle peut prendre différentes formes : examen écrit, oral, compte-rendu, rapport écrit, évaluation par les pairs...

Practical info

Location(s)

Toulouse

Non-contractual information