Computational Fluid dynamics: Galerkin discretization methods for the incompressible Navier-Stokes equations

Michele Giuliano Carlino[1,2]

[1]INRIA Bordeaux Sud-Ouest, Bordeaux, France
[2]University of Bordeaux, Bordeaux, France

This course aims in providing the fundamentals and essentials of mathematical models and Finite Element (FE) methods for partial differential equations describing the motion of fluids constrained to be incompressible.

The course will be conducted in gradually increasing degrees of complexity. It will start with Stokes equations,without considering the nonlinearity given by the convective term. Then we will study the Navier-Stokes equations for stationary regimes by adding the nonlinear convective part. With this class of equation we will see the different linearization methods needed for the numerical schemes. Finally, the best known and most recent discretization methods for the complete incompressible Navier-Stokes equations for nonstationary incompressible viscous flows will be analyzed.

At the end of the course, the student should be able to (i) derive convergence estimates of weak formulations of the equations under consideration; (ii) dicretize these weak formulations via Galerkin methods; and (iii) implement the studied schemes on a computer.

With respect to point (iii) of the objectives, part of the teaching will be directed to the implementation of the analyzed methods using FreeFem++.