basque center for applied mathematics

Introduction to computational methods in Fluids Mechanics

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Abstract:

The aim of this course is to show the most usual techniques in the numerical approximation of parabolic and hyperbolic equations, with stress in Fluid Mechanics. We focus on finite elements and finite volume methods with different time integration techniques. The course will be mostly practical, with special attention to those aspects related to the implementation and visualization.

After a brief theoretical introduction, the student will have to create his own code in MATLAB, so as to carry out a supervised work.

A knowledge of MATLAB and basic numerical approximation techniques in PDEs are necessary to follow this course.

Program:

1. Finite elements
   (a) Theoretical introduction
   (b) Spatial discretization in one and two dimensions
   (c) Time integration
   (d) Advanced techniques: domain decomposition and multi-grid
2. Finite volumes
   (a) Theoretical introduction to conservation laws and their numerical approximation
   (b) First order conservative schemes: upwind, centered schemes
   (c) High-order schemes: MUSCL

Bibliography:

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2. R. Glowinski, Numerical Methods for Fluids (Part 3). In "Handbook of Numerical analysis", vol. IX (Ph. Ciarlet and J.L. Lions eds.). Elsevier, 2003.

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3. C. Hirsch, *Numerical computation of internal and external flows*, Vol. 1 and 2. John Wiley and Sons, 1988.

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5. A. Iserles, *A First Course in the Numerical Analysis of Differential Equations*. Cambridge Texts in Applied Mathematics, Cambridge University Press, 1997.

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7. A. Quarteroni y A. Valli, *Numerical Approximation of Partial Differential Equations*. Springer-Verlag, 1994.