Advanced Finite Volumes

ECTS: 3 ECTS

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UNIVERSITY WHERE THE COORDINATOR IS: USC

HAVE YOU GIVEN PERMISSION TO RECORD YOUR CLASSES? Yes

SUBJECT CONTENTS

Contents

1. Introduction: systems of hyperbolic conservation laws.
    - Basic concepts and examples of environmental and industrial interest.
    - Types of solutions: classic, weak and entropics
    - The Riemann problem.
    - Applications.
2. Finite Volume Methods for hyperbolic problems.
    - 2.1 Resolution of linear onedimensional problems.
        - Basic concepts
        - Upwind methods
        - Godunov method
        - Stability conditions
        - Applications.
    - 2.2 Resolution of nonlinear onedimensional problems
        - Conservative methods
        - Upwind methods
        - Lax-Wendroff theorem
        - Godunov method

- Approximated Riemann solvers
- Flux vector splitting
- Conservative schemes for conservation laws with source terms
- Monotone schemes and TVD schemes
- Schemes consistent with the entropy condition
- Applications

2.3 Resolution of hyperbolic nonlinear bidimensional problems

- Dimensional-splitting schemes
- Finite volume definition on unstructured meshes
- Conservative shemes
- Conservative schemes for conservation laws with source terms
- Applications

METHODOLOGY

Basic notes on the subject containing exercises, the indicated bibliography and additional Web sites with complementary documentation will be provided to the students.

In the theoretical classes the mathematical methods and models to apply will be presented.

In the practical classes problems will be solved by students and practices to implement using computers will be defined. These classes will try to deepen the understanding of the methods that will be applied to the numerical resolution of problems, affecting the validation of the results by means of analytical and/or experimental solutions if it is possible.

Group work and group or individual presentations will be promoted.

LANGUAGE USED IN CLASS: Spanish, Will depend on the audience.

IS IT COMPULSORY TO ATTEND CLASS? Students can attend via conference system.

BIBLIOGRAPHY

B. van Leer. Towards the ultimate conservative difference schemes III. Upstream-centered difference schemes for ideal compressible flow. J. Comput. Phys., 23, 263-275. 1977.

S.K. Godunov. Ecuaciones de la Física Matemática. URSS. 1978.

A. Harten, P. Lax e van Leer. On upstream differencing and Godunov-type schemes for hyperbolic conservation laws. SIAM Rev., 25, 35-61.1983.

R. LeVeque. Numerical Methods for Conservation Laws. Basel. 1990.

E. Gowlewski e P.A. Raviart. Numerical Approximation for Hyperbolic Systems of Conservation laws, volume 118 of Applied Mathematic Sciences Springer, 1996.

E. F. Toro. Schock-capturing methods for free-surface shallow flows. John Wiley & Sons. 2001

R. LeVeque. Finite Volume Methods for Hyperbolic Problems. Cambridge University Press. 2002.

M. E. Vázquez-Cendón. Introducción al Método de Volúmenes Finitos. Colección de Manuais Universitarios. Servizo de Publicacións da Universidad de Santiago de Compostela. 2008.

E. F. Toro. Riemann solvers and Numerical Methods for fluids dynamics: a practical introduction. Springer-Verlag; Berlin, 3rd ed. 2009.

M. E. Vázquez-Cendón (Ed.). Lecture notes on numerical methods for hyperbolic equations: short course book. 2011

M. E. Vázquez-Cendón. Solving Hyperbolic Equations with Finite Volume Methods. Springer. 2015.

SKILLS

Basic:

CG3: To be able to integrate knowledge in order to state opinions using information that even incomplete or limited, include reflecting on social and ethical responsibilities linked to the application of their knowledge.

CG5: To have the appropriate learning skills to enable them to continue studying in a way that will be largely self-directed or autonomous, and also to be able to successfully undertake doctoral studies.

Specific:

CE4: To be able to select a set of numerical techniques, languages and tools, appropriate to solve a mathematical model.

Numerical simulation specialization:

CS2: To adapt, modify and implement software tools for numerical simulation.

WILL YOU BE USING A VIRTUAL PLATFORM? Yes. Moodle (USC)

WILL YOU BE USING ANY SPECIFIC SOFTWARE? Yes. MATLAB, OCTAVE

CRITERIA FOR THE 1ST ASSESSMENT OPPORTUNITY

50% of the final grade: the students will present exercises and proyects to be evaluated. The skills developed in these tasks are: CG3, CG5, CE4 and CS2.

50% of the final grade: the students will sit an exam where they can use some helping materials. The skills developed in the exam are: CG3, CG5 and CE4.

CRITERIA FOR THE 2ND ASSESSMENT OPPORTUNITY

The same as in the first assessment opportunity.