Computational techniques in thermal and fluids engineering

Academic Year: (2019 / 2020) **Review date: 13-05-2019**

Department assigned to the subject: Department of Thermal and Fluids Engineering

Coordinating teacher: ACOSTA IBORRA, ANTONIO

Type: Compulsory ECTS Credits : 6.0

Year : 1 Semester : 1

STUDENTS ARE EXPECTED TO HAVE COMPLETED

A previous course or courses on the following topics:
- Fundamentals of fluid mechanics
- Fundamentals of heat transfer
- Partial derivative calculus
- Elementary programming notions.

COMPETENCES AND SKILLS THAT WILL BE ACQUIRED AND LEARNING RESULTS.

Competences that the student will acquire in the present course:
- Understanding of the underlying concepts and fundamental hypothesis of computational methods in engineering.
- Practical skills in using the main computational techniques (numerical methods for finding the roots of equations, solution of equation systems, numerical differentiation and integration).
- Application of numerical techniques in the efficient modeling and solution of engineering problems, with special emphasis in thermal and fluid engineering problems.
- Critical analysis and interpretation of the simulation results, including error estimation and validation of results.

As a result of the above competences, the student will be able to apply the numerical tools of the course to solve engineering problems and to correctly assess the simulation results obtained with these tools.

DESCRIPTION OF CONTENTS: PROGRAMME

- Introduction to computational modeling.
- Main numerical techniques in engineering: sources of innaccuracy in numerical simulation, root calculation of a function, numerical integration and differentiation, solution of ordinary and partial differential equations.
- Application of numerical techniques for the solution of problems in Thermal and Fluids Engineering (heat transfer, potential flow, boundary layer, etcetera) using different methodologies of discretization (finite differences, finite volume, etcetera).

LEARNING ACTIVITIES AND METHODOLOGY

- Lectures, in which the main theory of the course is presented. To facilitate the learning of the theory, a set of class presentations and notes will be delivered to the students together with a reference list of basic text books. (2 ECTS)
- Practical seminars in computer room, in which the computational techniques learned during the course will be coded in a high-level programming language (Matlab or Python). These practical sessions will also serve to solve the main practical questions raised by the students about numerical methods. (2 ECTS)
- All students will solve problems and work on projects intended to improve their knowledge of numerical techniques and check their learning progression. The marks derived from these problems and projects will constitute the grade assigned to the continuous evaluation of the course. (2 ECTS)
- In addition to the enquiries solved in class, there will be tutorial sessions scheduled in the instructor office in which a student can ask questions concerning the course.

ASSESSMENT SYSTEM

1) Continuous evaluation: work on problems and projects delivered during the course, which will consist in programming, solution and analysis of general problems as wells as problems in the field of Thermal and Fluids Engineering.

2) Final exam: attendance examination, which will consist of exercises on the solution of problems using numerical techniques, including the analysis or development of the numerical schemes and their coding in a computer program.
The continuous evaluation will account for the 50% of the final mark of the course and the final exam will account for the rest (50%).
For passing the course, it will be compulsory to obtain a minimum mark in the continuous evaluation as well as in the final exam. The minimum mark will be of 3 (over a mark of 10).

% end-of-term-examination:	50
% of continuous assessment (assigments, laboratory, practicals…):	50

BASIC BIBLIOGRAPHY

- C. Hirsch Numerical computation of internal and external flows (2nd edition): The fundamentals of computational fluid dynamics, Elsevier Ltd, 2007
- G.R. Lindfeld; J.E.T. Penny Numerical Methods Using Matlab. (3rd edition)., Elsevier Ltd., 2012
- J.D. Anderson Computational fluid dynamics: the basic with applications., McGraw-Hill, 1995

ADDITIONAL BIBLIOGRAPHY

- C. Hirsch. Numerical computation of internal and external flows., John Wiley & Sons, 1994
- D.A. Anderson, J.C. Tannehill y R.H. Pletcher Computational fluid mechanics and heat transfer, Taylor & Francis, 1984
- G.R. Lindfeld; J.E.T. Penny Numerical Methods Using Matlab. (3rd edition)., Elsevier Ltd., 2012
- J.F. Wendt (ed.) Computational fluid dymanics. An introduction. (2nd Edition)., Springer, 1996
- J.H. Ferziger; M. Peric Computational methods for fluid dynamics., Springer, 1999
- L.V. Fausett Applied numerical analysis using Matlab., Prentice Hall, 1999
- R. Butt Introduction to numerical analysis using MATLAB., Jones and Bartlett Publishers, 2010
- R. Peyret y T.D. Taylor Computational methods for fluid flow., Springer, 1983
- R.J. LeVeque Numerical methods for conservation laws. (2nd edition)., Birkhäuser, 1992
- S. Attaway Matlab. A Practical Introduction to Programming and Problem Solving. (2nd edition)., Elsevier Ltd., 2012
- S.V. Patankar Numerical heat transfer and fluid flow., Taylor & Francis, 1980

BASIC ELECTRONIC RESOURCES

- C. Hirsch . Numerical computation of internal and external flows (2nd edition): The fundamentals of computational fluid dynamics.: http://www.sciencedirect.com/science/book/9780750665940